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The Engineer

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A French Locomotive Boiler Repairing Works.

Reconditioning the Turbines of the Mauretania.

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Air Consumption and B.H.P. in Internal Combustion Engines.

High-Tension Transmission Lines—No. VI.

Institution of Naval Architects—No. II.

Control of Locomotive Running.

PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES:—
BEARING PLATES FOR RAILS.
Tenders due on the 6th May, 1924.
Tender forms obtainable from above. 5529

Crystal Palace School of PRACTICAL ENGINEERING (Founded in 1872).
Principal: J. W. WILSON, M.I.C.E., M.I. Mech. E.
Vice-Principal: MAURICE WILSON, A.M.I.C.E.
The 154th SESSION will COMMENCE on APRIL 29th. 5535

Busk Studentship in Aero- NAUTICS.
This STUDENTSHIP, founded in memory of E. T. Busk, open to British subjects of British descent, and of value of about £190 is to be AWARDED SHORTLY.
Forms of application and conditions of appointment may be obtained from Prof. B. M. JONES, Engineering Laboratory, Cambridge. 5541

Aberdeen Corporation Water- WORKS.
EXTENSIONS, 1920.
CONTRACT NO. 18—PIPING.
The Town Council of Aberdeen are prepared to receive TENDERS from competent persons willing to enter into a contract for the MANUFACTURE and DELIVERY of about 5500 LINEAL YARDS of 30in., 20in., 16in., and 12in. diameter PIPES and SPECIALS of the following alternative types, viz.:—
(A) CAST IRON.
(B) MILD STEEL (LAP WELDED).
The drawings may be inspected and specification, schedule of quantities and form of Tender obtained on and after 11th April, 1924, on application at the Water Engineer's Office, 41½, Union-street, Aberdeen. Early application is desirable and no specification will be given out after 21st April.
For each specification a deposit of Five Pounds sterling will be required, which sum will, after a Tender has been accepted, be returned to the tenderer, provided that he shall have sent in a bona fide Tender, based on the drawings, specification, and schedule of quantities provided, with the schedule of quantities fully priced out in detail, and shall not have withdrawn the same.
The employment of labour shall be in accordance with the conditions of the Unemployment Grants Committee.
Tenders, on the forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for Pipes," are to be addressed to the undersigned. No Tender delivered after Noon on 29th April, 1924, will be considered.
The Town Council do not bind themselves to accept the lowest or any Tender.
GEORGE MITCHELL, M. Inst. C.E., F.G.S., Water Engineer.
Water Engineer's Office, 41½, Union-street, Aberdeen.
7th April, 1924. 5488

Bengal-Nagpur Railway Com- PANY, LIMITED.
The Directors are prepared to receive TENDERS for 3 MILD STEEL RIVETS (FOR VERY EARLY DELIVERY).
Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, E.C. 2, on or after 15th April, 1924.
A fee of 10s. will be charged for the specification, which is not returnable.
Tenders must be submitted not later than Noon on Tuesday, 29th April, 1924.
The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.
By Order of the Board,
R. C. VOLKERS, Secretary.
5531

East Indian Railway.
The Directors are prepared to receive up to 11 a.m. on Wednesday, the 30th April instant, TENDERS for the SUPPLY of 3 METALS (Lead Pig and Tin Ingots).
Copies of the specification can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.
G. E. LILLIE, Secretary.
79-76, King William-street, London, E.C. 4,
16th April, 1924. 5551

County of London.
The London County Council invites TENDERS for the SUPPLY, DELIVERY, and ERECTION of MOTOR-DRIVEN BELT CONVEYOR COAL-HANDLING PLANT for Greenwich Power Station.
The specification, form of Tender, and general conditions may be obtained from the General Manager, London County Council Tramways, Victoria Embankment, W.C. 2, upon payment of a deposit of £2. This amount will be returnable only if a bona fide Tender is submitted and not withdrawn. Particulars of the work may be obtained at the Tramways Offices, Victoria Embankment, before payment of the deposit.
Tenders must be delivered to the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, not later than 4 p.m. on Monday, 19th May, 1924. No Tender received after that time will be considered. The Council does not bind itself to accept the lowest or any Tender.
JAMES BIRD, Clerk of the London County Council.
The County Hall, Westminster Bridge, S.E. 1. 5536

The South Indian Railway Com- PANY, Limited, are prepared to receive TENDERS for the SUPPLY of:—
1. ROLLED STEEL DISC WHEELS and AXLES for CARRIAGES and WAGONS and STEEL AXLES for WAGONS.
2. STEEL TYRES for CARRIAGES and WAGONS.
3. STEEL DRAW BARS for WAGONS.
Specifications and forms of Tender will be available at the Company's Offices, 21, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Wheels and Axles," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 2nd May, 1924.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of 10s. for each copy of each specification.
Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.
A. MUIRHEAD, Managing Director.
12th April, 1924.
21, Petty France, S.W. 1. 5532

Metropolitan Water Board.
SUPPLY OF LATHES, &c., FOR BOARD'S TESTING SHOPS, ROSEMAN-STREET, CLERKENWELL, E.C. 1.
The Metropolitan Water Board invite TENDERS for the SUPPLY of LATHES, and other MACHINE TOOLS, for their Testing Shop, Roseman-street, Clerkenwell, E.C. 1.
Forms of Tender and specification giving full particulars may be obtained from the Chief Engineer, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1, by personal application (Room 155), or upon forwarding a stamped addressed brief envelope.
Tenders must be on the official forms, enclosed in sealed envelopes, and addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," endorsed "Tender for Lathes, &c.," and delivered at the offices of the Board not later than 11 a.m. on Wednesday, 30th April, 1924.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER, Clerk of the Board.
Offices of the Board, New River Head, 173, Rosebery-avenue, E.C. 1,
12th April, 1924. 5524

Metropolitan Water Board.
SUPPLY AND ERECTION OF FENCING.
SHOOTERS HILL PUMPING STATION, KENT.
The Metropolitan Water Board invite TENDERS for the SUPPLY and ERECTION of approximately 1000 YARDS WROUGHT IRON FENCING at their Shooters Hill Works in the Kent District.
Forms of Tender, specifications, and drawings giving full particulars may be obtained from the Chief Engineer, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1, by personal application (Room 155), or upon forwarding a stamped addressed brief envelope.
Tenders must be on the official forms, enclosed in sealed envelopes and addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," endorsed "Tender for Fencing, Shooters Hill," and delivered at the offices of the Board not later than 11 a.m. on Tuesday, 29th April, 1924.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER, Clerk of the Board.
Offices of the Board, New River Head, 173, Rosebery-avenue, E.C. 1,
12th April, 1924. 5525

Richmond Main Sewerage Board.
CONTRACTS FOR STORES.
The Board are prepared to receive TENDERS for the SUPPLY and DELIVERY to their works during the year ending May 31st, 1925, of the following STORES:
STEAM COAL (Welsh).
GREY LIME.
BUXTON LIME.
SEWAGE PRECIPITANTS.
FILTER PRESS CLOTH.
Specifications may be inspected and further particulars obtained on personal application only at the office of Mr. William Fairley, M. Inst. C.E., Engineer to the Board, West Hall-road, Kew Gardens, Surrey.
Sealed Tenders, on the forms provided, to be delivered to the undersigned on or before Tuesday, May 13th, 1924.
The Board do not bind themselves to accept the lowest or any Tender.
J. LESLIE G. POWELL, Clerk to the Board.
The Sessions House, Richmond, Surrey, 9th April, 1924. 5522

PUBLIC NOTICES

TO PIPE FOUNDERS.

The Fylde Water Board Invite TENDERS for the SUPPLY and DELIVERY of about 23,000 TONS of 27in. and 24in. CAST IRON SOCKET and SPIGOT PIPES, and about 200 TONS of SOCKET and SPIGOT and FLANGED SPECIALS.
An alternative TENDER is INVITED for the above PIPES in CAST IRON LINED with CONCRETE.
Specification can be obtained from the undersigned.
The Board do not bind themselves to accept the lowest or any Tender.
JNO. COOK, Engineer.
Sedum-street, Blackpool, 8th April, 1924. 5489

Wandle Valley Joint Sewerage BOARD.
TO CONTRACTORS AND DEALERS IN MACHINERY, &c.
The above Board invite TENDERS for the PURCHASE, DISMANTLING and REMOVAL of BOILERS, STEAM and GAS ENGINES, and PUMPING MACHINERY, &c., at their Sewage Works, Byrrove-road, Merton, S.W. 19, in accordance with the general conditions prepared by Messrs. Wilcox and Raikes, Engineers, of London and Birmingham.
Full particulars, together with forms of Tender and permit to view, may be obtained on application to the undersigned, to whom Tenders should be delivered on or before Monday, May 12th next.
ROBT. M. CHART, Clerk and Surveyor to the Board.
Lower Green, Mitcham, Surrey. 5515

Borough of Richmond (Surrey).
WATER ENGINEER AND MANAGER.
The Town Council invite APPLICATIONS for the APPOINTMENT of ENGINEER and MANAGER to the Borough Waterworks Undertaking.
Candidates must be Associate Members of the Institution of Civil Engineers.
Age not to exceed 40 years.
Salary £600 per annum (no bonus), with residence, fuel, and light provided by the Council.
The Superannuation, &c., Act, 1923, is in operation in the Borough, and the appointment will be made subject to the candidate appointed passing satisfactorily an examination by the Medical Officer of Health within seven days of his appointment. He will also be required to contribute to the Superannuation Scheme.
The appointment will be subject to one month's notice on either side.
Applications (which must be made on a form which on request, will be sent to intending candidates), accompanied by copies of not more than three recent testimonials, must reach the undersigned not later than Tuesday, the 29th April, 1924.
Personal canvassing is strictly prohibited.
HENRY SAGAR, Town Clerk.
Town Hall, Richmond, Surrey, 8th April, 1924. 5516

County Borough of Warrington.
WATERWORKS DEPARTMENT.
ASSISTANT ENGINEER.
The Corporation of Warrington invite APPLICATIONS from persons who have been trained in a Waterworks Undertaking for the POSITION of an ASSISTANT ENGINEER.
Applicants with mechanical knowledge preferred.
The person to be appointed must not exceed 30 years of age and will have to devote the whole of his time to the duties of his office.
Salary £260 per annum, increasing £13 per annum to a maximum of £350 per annum.
Applications, stating age and particulars of the candidate's career, with copies of three testimonials, must be delivered to the undersigned at his office on or above the 10th May, 1924.
Canvassing is strictly prohibited.
A. T. HALLAWAY, Town Clerk.
Town Hall, Warrington, 14th April, 1924 5544

PUBLIC NOTICES

Singapore, Straits Settlements.
WATER DEPARTMENT.
ASSISTANT SUPERINTENDENT OF WATER MAINS AND SERVICES.
The Municipal Commissioners of Singapore REQUIRE an ASSISTANT SUPERINTENDENT of MAINS and SERVICES in the Water Department, age about 25 to 30, unmarried, on a three years' agreement, with possible extension. Preference will be given, other things being equal, to ex-Service men. Applicants must be "Registered Plumbers," with experience in the work of a mains and services department under a water authority in the United Kingdom, and must be accustomed to carrying out the Model By-laws and Regulations. They should be accustomed to controlling men, and experience in a workshop and in training men will be an advantage. A bonus of 40 dollars will be given on the selected candidate's passing successfully an examination in colloquial Malay within twelve months of his arrival in Singapore. Salary 4500 dollars for the first, 5040 dollars for the second, and 5250 dollars for the third year, paid monthly in dollars, the currency of the Colony, the value of the dollar being two shillings and fourpence sterling. If re-engaged, the candidate, in his fourth year, would probably be placed in Class 6 of the salary scheme, in which the annual increments are 40 dollars per month and the maximum salary 540 dollars per month. The pay of the appointment for the first year at the above rate would be about £332. Such local transport allowance as may from time to time be sanctioned by the Commissioners will be paid. Free passage will be provided, with half-pay during the voyage out. The selected candidate must pass a medical examination. Applications, stating whether married or single, age, and place of birth and giving details of education, apprenticeship, training, and experience generally with war service, and referring to all the above requirements in detail, accompanied by copies (only) of testimonials and also personal references, are to be lodged with Messrs. C. C. LINDSAY and PEIRCE, MM. Inst. C.E., 180, Hope-street, Glasgow, Agents for the Commissioners (who will give further particulars if requested), not later than Tuesday, 22nd April. 5490

SITUATIONS OPEN

WANTED, ASSISTANT in Engineer's Office. Fully conversant with Signalling and Interlocking; good draughtsman.—Apply, stating age, experience, and salary required, to the CHIEF ENGINEER, Dublin and South-Eastern Railway, Westland-row, Dublin. P5902 A

WANTED for Small Works in East Anglia, ASSISTANT MANAGER, under 35. Public Works Contractor's Agent might suit. Seven o'clock man. State age, experience, when disengaged, and salary required.—Address, 5554, The Engineer Office. 5554 A

PULVERISED FUEL.—ENGINEER REQUIRED, to act as Travelling Representative for Pulverised Fuel Apparatus of British manufacture. Thorough knowledge of combustion problems and of boiler management is essential, also experience of negotiations with power and fuel users.—Address, 5547, The Engineer Office. 5547 A

RATE FIXER and DEMONSTRATOR REQUIRED for Machining Department of Midlands Firm of Steel Forgings Manufacturers specialising in Crank Shafts. Essential qualifications include expert knowledge of machining times and ability as a practical demonstrator from actual experience of above class of work.—Address, 5445, The Engineer Office. 5445 A

WORKS MANAGER WANTED for Heavy Engineering Works in the Midlands. Age between thirty and forty.—Address, stating qualifications and salary, P5903, The Engineer Office. P5903 A

WANTED, First-class DRAUGHTSMAN for the North of England, with experience in the design of machinery for Stone Crushing, Screening and Cement Making and the Lay-out of complete Plants.—Address, 5470, The Engineer Office, stating details of experience, age, and salary expected. 5470 A

WANTED, TEMPORARY DRAUGHTSMAN, Fully experienced in Quay Construction and Ferro-concrete Work.—Address, P5901, The Engineer Office. P5901 A

DRAUGHTSMAN REQUIRED, Experienced in 'Bus Body Design.—State age, experience, and salary required to BRUSH ELECTRICAL ENGINEERING CO., Ltd., Falcon Works, Loughborough. 5520 A

DRAUGHTSMAN, Experienced, Mechanical, REQUIRED for large Engineering Works in South-Eastern District; must be a first-class designer for industrial machines; only real designers with first-class experience and qualifications need apply. State salary.—Address, 5523, The Engineer Office. 5523 A

DRAUGHTSMAN WANTED by a Firm in the Midlands, accustomed to designing Steel Structures, Coal Screening and Sorting Plants. Must be well up in stresses and strains.—Address, stating age, experience, salary required, and when at liberty, 5527, The Engineer Office. 5527 A

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SITUATIONS OPEN (continued)

DRAUGHTSMAN, Tramway and Railway Rolling Stock.—Apply (letter only), stating age, experience, and salary, to the CAR MANAGER, The English Electric Co., Ltd., Box 36, Preston, Lancs. 5519 A

DRAUGHTSMAN.—WANTED, Skilled DRAUGHTSMAN, Aircraft experience preferred, but applicants with good engineering experience will be considered.—Reply, stating age and salary required, to WESTLAND AIRCRAFT WORKS, Yeovil. 5523 A

ELECTRIC LIFT ENGINEERS REQUIRE a thoroughly competent DRAUGHTSMAN. Must have initiative, combined with quickness and accuracy. Knowledge of Goods and Passenger Lift work preferred, but not essential. Good all-round crane man might be suitable.—Apply, stating age, experience, and salary required, to R. A. EVANS, Ltd., Prospect-road, Leicester. P8975 A

ENGINEER DRAUGHTSMAN for Boilermakers and Constructional Engineers (small works, Midlands); practical experience necessary. To Take Charge of Drawing-office and Act as Assistant Works Manager. To the right man the position will be a good and progressive one. State age, experience, &c.—Address, 5518, The Engineer Office. 5518 A

HEATING DRAUGHTSMAN REQUIRED, Fully experienced, capable of scheming and estimating. State age, experience, and salary required to the BRIGHTSIDE FOUNDRY and ENGINEERING CO., Ltd., 17, Summer-row, Birmingham. P8977 A

MECHANICAL DRAUGHTSMAN, Experienced, at weekly rate of £3 0s. 11d., which includes Civil Service bonus (at present 23s. 11d.), REQUIRED IMMEDIATELY. Applicants must be over 21 years.—Apply by letter to the COMMANDANT, Experimental Station, Porton, near Salisbury. P8978 A

MECHANICAL and GENERAL ENGINEERING DRAUGHTSMEN REQUIRED, to Prepare Detail Drawings and Schemes in drawing-office of large manufacturing works in the Midlands. The following training is essential:—

At least two years' day student in recognised College or University, College Diploma or Engineering Degree, and three years in workshop of well-known firm of general engineers; at least three years' drawing-office experience.

Address in confidence, stating age, training, experience, salary required, and when at liberty, 5459, The Engineer Office. 5459 A

SEVERAL Capable DRAUGHTSMEN WANTED, preferably with experience in designing Light Mechanical Motions or Automatic Machinery.—State age, experience, and salary to Box 714, Advertising Offices, 54, Queen Victoria-street, London, E.C.4. 5497 A

FOREMAN REQUIRED for Railway Carriage Building Dept.; must have first-class experience in all classes of work for home and abroad, capable of controlling men and arranging shop prices.—State age and full experience, also salary required, to WORKS MANAGER, Cravens Railway Carriage and Wagon Co., Ltd., Darnall, Sheffield. 5540 A

SITUATIONS WANTED

ENGINEER DRAUGHTSMAN (29) SEEKS Responsible APPOINTMENT; 9 years shops, 2 years buying, 2 years D.O., including 2 years' continental experience; fluent French.—Address, P8972, The Engineer Office. P8972 B

ENGINEER, M.I. Mar. E. (35), British, REQUIRES POSITION ashore, home or abroad; 14 years' sea-going experience, 6 years as chief engineer; knowledge of ship repairing, marine salvage, erecting shop transmission shafting and laying out of machines, pumping station for dry docks and accessories, dredgers and locomotives, erecting and running sheep shearing machines and hydraulic presses; bookkeeping; speaks Spanish fluently, also some Italian, French and Portuguese.—Address, P8971, The Engineer Office. P8971 B

MECHANICAL and COMMERCIAL ENGINEER, Australian, returning home after extensive experience in England, Canada, and U.S.A., DESIRES POST, REPRESENTATIVE first-class Firm. Well versed in business methods and modern salesmanship. Highest credentials, A.M. Inst. Mech. E.—Address, P8976, The Engineer Office. P8976 B

POST REQUIRED, Home or Abroad, by Engineer experienced in management, design, estimating, and salesmanship.—Address, P8951, The Engineer Office. P8951 B

YOUNG MAN (22), G.I. Mech. E. (Passed A.M.I. Mech. E. exam.), 3 years shops and drawing-office, REQUIRES APPOINTMENT with prospects.—Address, P8974, The Engineer Office. P8974 B

BOILERMAKER (23) SEEKS BERTH with View to Improvement (home or abroad); good refs., City Guilds and B.E., full tech. certificates.—HUXLEY, 99, Cattledown-road, Plymouth. P8979 B

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Engineering undertakings reorganised by specialists.
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PARTNER WANTED for Established South Wales Engineering Sales Organisation; profits over £2000 per annum during bad period; good opportunity for salesman with good personality; expenses and half share of profits; consideration only £1000. Only first-class applications will be considered for this important business.—Address, 5553, The Engineer Office. 5553 C

EDUCATIONAL

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter., and B.Sc.) personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M. Inst. C.E., M.E.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time.—8/11, Trafford Chambers, 58 South John-street, LIVERPOOL. Ex. B

SURVEYING AND LEVELLING. — EXCELLENT OPPORTUNITY to ACQUIRE thorough practical INSTRUCTION on WORK.—Address, E. MOUL, Bollybank, Woking. P8857 B

No. 7 April 15. 2/6.
J.S.I.
A Monthly Publication produced by THE INSTITUTE OF PHYSICS with the co-operation of THE NATIONAL PHYSICAL LABORATORY.
JOURNAL OF SCIENTIFIC INSTRUMENTS,
Subscription 30/- per annum. 10, Essex Street, LONDON, W.C.2. 4946

AGENCIES

A FIRM of GENERAL ENGINEERS Dealing with precision work and assemblies, internal combustion engines, REQUIRES AGENTS on commission for Birmingham, Newcastle, Swansea, Manchester, Lincoln, and Glasgow Districts.—Address, 5534, The Engineer Office. 5534 D

RAILWAY AND DOCK ENGINEERS
ARE REQUESTED to SEND INQUIRIES for all RAILWAY MATERIALS and ROLLING STOCK, any quantity, for all gauges, to—
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E. H. NEAL and CO.,
Plant House,
EALING, LONDON, W. 5. 5348 D

ENGINEER SALESMAN, with Unique Connection among engineering firms and staff of trained salesmen, REQUIRES first-class AGENCY. Only first-class proposition considered from substantial company.—Address, Peter, The Engineer Office. P8962 D

ENGINEER, with First-class Hydraulic Experience, is prepared to act as LONDON REPRESENTATIVE for firms manufacturing pipes, valves, or other equipment. Office in Victoria-street.—Address, P8970, The Engineer Office. P8970 D

AGENCY.
FULLY QUALIFIED ENGINEERS, with office in good position in Westminster, SEEK ONE or MORE GOOD AGENCIES. High-class manufactures only entertained. We are energetic, capable engineers, with good connection, and desire to represent far-sighted and up-to-date manufacturers only.
Address, 5362, The Engineer Office. 5362 D

NEW ZEALAND.—An ENGINEER (A.M.I.M.E.), proceeding to the Colony next month, is DESIROUS to REPRESENT a good FIRM of ENGINEERS. Thoroughly conversant with modern machine tools.—Address, 5543, The Engineer Office. 5543 D

TO MANUFACTURERS WISHING TO INCREASE THEIR TRADE IN CHINA.—A FIRM of MACHINE TOOL MAKERS, with extensive knowledge of trade in China and about to send a practical man to that country, is willing that he REPRESENTS ONE or TWO other HOUSES manufacturing non-competitive lines on basis of contributory expenses.—Address, 5542, The Engineer Office. 5542 D

MISCELLANEOUS

CHINA
as a Market for British Products.

Engineer with intimate experience of Selling Engineering Products in China wishes to get in touch with M nufacturer interested in this market.—Address, P8906, The Engineer Office. P8906 E

PATENTS

THE PROPRIETOR of BRITISH PATENT No. 148,866, dated June 8, 1914, relating to "Improvements in and relating to Vessels for Serving Ice cream and the like," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and securing its practical working in Great Britain.—Inquiries to B. SINGER, Stezer Building, Chicago, Ill. 5479 H

THE PROPRIETORS of BRITISH PATENT 106,018, for "Time Recording Apparatus for Employees and the like," are DESIROUS of ENTERING into NEGOTIATIONS with a firm or firms for the GRANT of LICENCES on reasonable terms.—Inquiries to be addressed to F. W. LE TALL, 2, Norfolk-street, Strand, London, W.C.2. 5526 H

FOR SALE

ALL MODERN TOOLS, Overhauled and Cheap:—Vertical Three-throw Heavy Pressure Pump, by Pearns; No. 5A Potter and Johnson Checking Auto, £125; 6ft. Fondisk (Tapping) Radial Drill, £125; 14in. and 24in. Pillar Shapers; Surface Grinders, Hood Bros. (U.S.A.), £85; Tool and Cutter Grinders, Jones and Shipman; 3in. Power Presses, Taylor and Challen; Auto Gear Cutters for small spurs; Planishing and Riveting Power Hammers; Drills, 20in./38in.; Single and Three-spindle sensitive and Geared Drills, from £8; Millers (Universal) No. 2 B. and S. and Cincinnati, from £90; Vertical and Lincoln Type Millers; High-speed Cast and Tool-room Lathes, 6in./9½in. Capstans, wire feed, 8in. (Ward), 14in.; High-speed Hack Saws; No. 2 Giant Keyseater, &c.—DOWNING, 12, Ivanbridge-road, Balsall Heath, Birmingham. 5356 G

BRAND NEW AND SECOND-HAND. Low Prices.
1500 Feet 12in. M.S. STEAM FLANGED
800 Feet 10in. Ditto.
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4000 Feet 6in. W.I. STEAM, Screwed and Socketed.
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20,000 Feet 5in. W.I. Ditto.
75,000 Feet 4in. W.I. Ditto.
20,000 Feet 3in. W.I. Ditto.
30,000 Feet 2½in. W.I. Ditto.
40,000 Feet 2in. GALVANISED W.I. Ditto.
25,000 Feet 1in. GALVANISED W.I. Ditto.
All other sizes from 3-8in. to 2in. New.
We can supply PIPE FITTINGS, W.I. and MALLEABLE, more cheaply than anyone else.
Write for our list before ordering.
GEORGE COHEN, SONS and CO., Ltd., 600, Commercial-road, London, E. 14. 5350 G

DIESEL ENGINES, 300, 550, 800, and 1200 B.H.P., M.A.N., with or without dynamos, condition as new; about one-third market price; seen London. All spares for above sizes in stock.—HICK DIESEL OIL ENGINES, Ltd., 70, Queen-street, E.C. 4. 5355 G

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ONE Willans 2-Throw, Central Valve, TRIPLE-EXPANSION STEAM ENGINE, coupled to a pair of Westinghouse 324 K.W. D.C. 6-pole Generators, each 220 volts, 702 amps., 450 r.p.m.
TWO Willans 2-throw DITTO; each coupled to one 977 K.W. 6-pole Westinghouse D.C. Generator, 450-550 volts, 512 amps., 450 r.p.m.
TWO Willans DITTO, each coupled to Westinghouse 195 K.W. D.C. Generator, 420 amps., 350 r.p.m.
TWO SETS SURFACE CONDENSING PLANT, each with Air Pump, Valves and all accessories; arranged for motor drive, and each capable of dealing with exhaust steam from a 500 K.W. set.
TWO 12in. DITTO (Simon and Sons), each for 500 K.W. set.
A very low price will be accepted for any of the above.
GEORGE COHEN, SONS and CO., Ltd., 600, Commercial-road, E. 14. Ex.

FOR IMMEDIATE SALE, SURPLUS TO REQUIREMENTS.
The following SECOND-HAND TOOLS in excellent condition:—
1 Fraser Horizontal and Vertical Grinder, No. 1.
1 Horizontal Grinder, Modern Tool Co., Eric.
2 Sin. S.S.S. Lathes, American Tool Co., Cincinnati.
1 Hin. by 24in. bore Turret Lathe, Brown and Ward.
10 No. 0 Bliss Inclinable Presses with feed rolls.
1 No. 20a Ditto Ditto.
1 Geared Blanking Press, with 2in., 3in., 4in. bolsters.
1 Universal Milling Machine with fittings.
Haign Drilling and other Machines.
ABBEY INDUSTRIES, Limited, Abbey Wood, S.E. 2. P8969 G

FOR SALE

ALFRED HERBERT, LTD. COVENTRY.

'Phone: 630 (8 lines). Wires: Lathe, Coventry.

REAL BARGAINS.

WE HAVE OVER
1000 MACHINES
which can be inspected at our Warehouse at Coventry
These comprise:—
(1) New machines at specially attractive prices.
(2) Re-conditioned second-hand machines.
(3) Good-class second-hand machines ready to be put to use.

The following is a selection of re-conditioned second-hand machines, unless otherwise stated.

BORING MACHINES.

40in. Webster and Bennett Duplex Boring Mill, two 40in. tables (Used).

Muir Horizontal Drilling, Boring, Studding, and Tapping Machines, Model "A," 2½in. spindle.

Dickinson Horizontal Boring, Drilling, Tapping, and Milling Machine, 2½in. spindle.

Ditto Ditto, 3in. spindle (Used).

GEAR-CUTTING MACHINES.

No. 65 Fellows Gear Shaper, complete with pump, countershaft, and spanners.

No. 6 Brown and Sharpe Automatic Gear Cutter, S.P. drive (Used).

6in. Bilgram Type Auto Bevel Gear Cutters, completely equipped (New).

No. 2 Reinecker Bevel Gear Cutter (Bilgram Type), max. pitch 3½ D.P.

MILLING MACHINES.

No. 2½ Garvin Plain Mill, geared with auto., long. feed to table, 18in. by 6in. by 13in. (New).

No. 1 Dow Plain Mill, back geared, C.P., 24in. by 7½in. by 18½in.

Putnam Semi-automatic Lincoln Type Mill, C.P. drive, long. feed, 15in. vert. adj., 9in. (New).

No. 25 Bilton Plain Mill, C.P. drive, 27in. by 8in. by 18in. (New).

PLANING MACHINES.

24in. by 24in. by 6ft. Bateman Planer, two heads, single-speed countershaft.

30in. by 30in. by 8ft. Redman Planer, two heads, V.S. countershaft.

9ft. by 9ft. by 26ft. Shanks Planer, two heads. Vickers drive (Used).

5ft. by 5ft. by 16ft. Stirk H.S. Planer, two heads and one on rear upright, Vickers drive (without motor) (Used).

TURRET LATHES.

No. 0. Alfred Herbert Combination Turret Lathes, S.P., 3 5-8in. through spindle, 10in. centres.

No. 2 Alfred Herbert Combination Turret Lathe, S.P., with standard equipment minus chuck and chuck guards, 2 13-16in. through spindle.

No. 16 Alfred Herbert Combination Turret Lathe, 11in. centres, 2 5-8in. through spindle, complete with chasing attachment (no chuck).

No. 4 Alfred Herbert Hexagon Turret Lathe, S.P., 3½in. by 42in.

BEFORE PURCHASING ELSEWHERE SEND FOR "SURPLUS LIST NO. 10" OR CALL AND INSPECT MACHINES AT OUR COVENTRY WAREHOUSE. 5535 G

FOR SALE.—
ONE 400 K.W., 470 K.V.A. ALTERNATOR, by B.T.H., 400/440 volts, 50 periods, 3-phase, power factor 80 per cent., 680 amps. With main driving pulley.
ONE Scott and Hodgson VERTICAL MARINE TYPE ENGINE, cylinders 13in., 20in., 47in. by 48in. stroke, 68 r.p.m., 1150 B.H.P., 160 lb. w.p. Fly-wheel 18ft., condensing surface 2300ft., A.D. brass tubes; air and circulating pump, 23in. by 12in. stroke. All in first-class condition.
ONE Scott and Hodgson VERTICAL ENGINE, cylinders 10 5-8in. by 15 5-8in. by 12in. stroke, 200 r.p.m., 80 B.H.P., 70 lb. w.p., complete with vacuum pump.
Offers for the above to CHIEF ENGINEER, Barber's Line, Holborne, near Warrington. 5545 G

FOR SALE, Crossley GAS ENGINE, 3123, No. 81,359, and ANTHRACITE PLANT; only worked about 18 months.—MATHERS, Engineers, Wellingborough. 5552 G

FOR SALE, THEODOLITES, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn road)

FOR SALE, LEVELS. DRAWING INSTRUMENTS, SECOND-HAND CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn road). Ex C

IMMEDIATE SALE, TWO Willans and Robinson 1 Enclosed STEAM ENGINES, direct coupled to Johnson and Phillips GENERATORS, 110 volts, 450 amps.; spare armature, all in good condition. Reasonable price.—ST. IVEL LTD., Frome. P8917 G

MACHINERY, PLANT, &c.

TWO Very Good Second-hand Three-drum Stirling WATER-TUBE BOILERS, each 1095 sq. ft. heating surface, re-insure 120 lb. per sq. inch, usual fittings.
SIX Very Good Dish-ended LANCASHIRE BOILERS, by Thompson, 30ft. by 8ft., re-insure for 120 lb. per sq. inch working pressure, ready for despatch.
LANCASHIRE BOILER, 17ft. by 8ft. 6in. diameter, re-insure 80 lb. pressure.
TWO CORNISH BOILERS, 28ft. by 6ft. diameter, re-insure 90 lb. pressure.
28in. stroke Heavy Duty Pillar Type SHAPING MACHINE, by Columbia Machine Tool Co., T-slotted table, 18in. by 28in. by 16in.
Powerful Double-geared BORING MACHINE, spindle 6in. diam., T-slotted table in halves, each 10ft. 6in. by 3ft. 6in., by J. Hetherington and Sons.
No. 3 12in. by 42in. UNIVERSAL GRINDING MACHINE, by Landis Machine Tool Co., take 3ft. 9in. between centres.
No. 2 Cincinnati VERTICAL MILLING MACHINE, working surface of table 40in. by 10½in., vertical adjustment 14in., cross traverse 12in.
TWO 2ft. gauge 4-6-0 SIDE-TANK LOCOMOTIVES (Baldwins), new in 1917, 175 lb. working pressure.
15-Ton "Wilson" Crane Type STEAM NAVVY, with 27ft. 6in. steel derricking jib, 1½ c. yards capacity, 4ft. 8½in. and 5ft. 3in. gauges.
4-Ton Double Chain GRABBING CRANE (Priestman), 36ft. jib, 4ft. 8½in. gauge, new carriage, &c., 80 lb. pressure.
Overhead Three-motor ELECTRIC TRAVELLING CRANES, suitable for 440-volt continuous current.
SEVERAL 5-TON, varying from 23ft. to 38ft. 2in.
ONE 2-TON, span 20ft.
ONE 15-TON, span 36ft. 2in.
All the above are in good condition and can be inspected on the premises in operation.

CATALOGUES of STOCK MACHINERY, 6000 Lots. Free on application. Inspection invited.

THOS. W. WARD, LTD.,
SHEFFIELD.

40 K.W. CRUDE OIL GENERATING SETS. First class.—CHICK, 9in Market-place, Southwark, S.E. 1. P8950 G

MACHINERY, &c. WANTED

WANTED, a ROLLING MILL Complete, Suitable for cogging and finishing high-speed and alloy steels; must be in guaranteed condition.—Give particulars of mill with spare rolls to Box E. 20, Mitchell's Advertising Offices, Liverpool. 5472 F

WANTED, ELECTRIC CAPSTAN, 200 Vol. A.C., 50 P., rope or chain pollard head or both, speed about 6 m.p.h.; load about six wagons, about 50 tons. Must be in first-class condition.—Address P8960, The Engineer Office. P8960 F

WANTED, Second-hand Steel-framed DERRICK CRANE, for occasional lifts of 15 tons, with quicker gear for light loads. State price, particulars, and where to be seen.—Address, 2, A. 123, c/o Deacon's, Leadenhall-street, E.C. 5508 F

WANTED, 15-20-Cwt. STEAM HAMMER, Cylinder 13in. to 15in. dia., 30 lb. pressure, single standard preferred.—Full particulars with price to W. G. BAGNALL, Ltd., Castle Engine Works, Stafford. 5444 F

RAILWAY WAGON, Good Second-hand, WANTED, 8/10 tons capacity, high sides, flat bottom, side doors, without cross rail, suitable for naphthalene main line traffic.—Address price and full particulars, 5555, The Engineer Office. 5555 F

TUBULAR BOILER, Loco. or Vertical Type, about 26in. to 42in. diameter, to steam at 100 lb., WANTED AT ONCE, with all fittings and mountings complete. Must be by good maker and in first-class condition. Give date built and lowest price.—Address, 5496, The Engineer Office. 5496 F

FOR HIRE

FOR HIRE, PUMPS and WELL-BORING TOOLS for Contractors' Deep Wells, &c., 3in. to 24in. dia.—E. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 978 Hop. 822 F

FOR SALE or HIRE, ELECTRIC MOTORS, from 60 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. F. WILLIAMS and SONS, 57, Queen Victoria-street, London, E.C. Tel., City 9033 Ex.

WORK WANTED

WANTED to MANUFACTURE, SPECIAL MACHINERY or ENGINEERS' APPLIANCES. Up-to-date machine plant for either heavy or medium work. Own foundry and pattern shop.—EASTON and JOHNSON, Ltd., Engineers, Taunton. Ex. H

THAT NEW CRANE SKIP.

A Self-Tipping Skip that costs out the Tipper! —and does more.
The Goldsbrough Skip is a positive Time and Money Saver.
Send a Postcard for details
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HAIGHS (OLDHAM), LIMITED, GLOBE IRONWORKS, OLDHAM, SOLICIT INQUIRIES for WORK of any description, suitable for fully equipped PATTERN SHOP, FOUNDRY and MACHINE SHOPS. Large or small jobs or quantities undertaken. KEEN PRICES QUOTED, QUICK DELIVERIES GIVE US A TRIAL.
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IRON CASTINGS.
REPETITION WORK AND MACHINE MOULDING A SPECIALITY.
The Heatly-Gresham Engineering Co., Ltd.
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IRON CASTINGS
up to 1 ton weight.
Enquiries Invited.
Cochran & Co., Annan, Ltd.,
ANNAN, Scotland.

J. KIRKALDY, Limited (Works: Burnt Mill, Essex).—We are organised to PRODUCE CASTINGS from 2 lb. to 2 tons. Cast Iron, Semi-steel, and Non-ferrous Castings. Coils of every description. Steel and Copper. Sheet Metal Work.
Over 40 years' experience is at your service. Send your inquiries along. 5152 M

WELL-EQUIPPED MECHANICAL and STRUCTURAL ENGINEERING FIRM invites INQUIRIES from the trade. Keen prices quoted.—MARCO, LTD., Leytonstone. 5511 M

L. D. BERRY and SONS, Engineers, The Albion Works, Romney street, Westminster, S.W. 1 (Established 1810), UNDERTAKE MACHINING and GENERAL WORK. Lathes up to 9in. centres with gap beds, Capstans, Automatics for bar work, Radial and Vertical Drills, Planing up to 9ft. by 4ft. by 4ft., Shaping, Milling, Gear Cutting to 36in. dia., Internal, External and Surface Grinding, Hand Forging, Small Press Work, &c. 5351 M

For continuation of Small Advertisements see page 8.

A Seven-Day Journal

The Shipyard Dispute.

In spite of the instructions of their executives the Southampton shipyard strikers, at a mass meeting on Thursday of last week, declined almost unanimously to resume work. Although the serious consequences to other shipyard workers elsewhere in the country which would result from a continuance of their recalcitrancy were fully explained to them, not more than 50 voted in favour of obeying their unions' instructions. No alternative was left to the employers except to enforce their decision to lock out throughout the country the members of all the unions whose men at Southampton persisted in remaining idle. The lock-out took effect on Friday evening, and is estimated to cover about 100,000 men. It does not apply to the boilermakers nor to the shipwrights, for the Southampton boilermakers have not been on strike, while the Southampton shipwrights have been expelled from their union. The Federation of Engineering and Shipbuilding Trades reported to the Employers' Federation that some of the Southampton men would resume work were it not that they were prevented from doing so by mass picketing. The employers, however, replied that while they agreed that protection should be afforded to such men as desired to resume work, the provision of such protection was a matter for the local authorities and not for the employers. The Southampton yards were left open for any men who cared and were able to work, and on Saturday it was reported that an additional number of men had gone back in spite of the pickets. On Tuesday, under the renewed persuasion of accredited trade union leaders, the strikers decided with but few dissentients to resume work immediately on the condition that a conference with the employers would be held at once with a view to securing uniformity between the Southampton and London rates of wages and conditions of employment.

Thames Bridges.

In connection with the settlement of Waterloo Bridge and its proposed widening and reconstruction, the London County Council on Tuesday had before it a recommendation from the Improvements Committee regarding the temporary bridge which it is intended to construct alongside Rennie's structure while it is being rebuilt. The committee took the view that time will not permit this temporary bridge to be erected on the basis of a firm contract price, and that it ought to be executed on a cost price plus percentage basis, provision being made for the immediate termination of the contract should it prove unsatisfactory. At the same meeting Sir Howell Williams introduced a motion to the effect that as the Charing Cross Bridge scheme could not be carried out for many years, the Improvements Committee should be asked to report upon the advisability of seeking parliamentary powers in connection with an alternative scheme, namely, the construction of a new bridge at the eastern end of Aldwych, which would form a continuation of Kingsway across the river at that point. A scheme of this nature was proposed a short time ago by Mr. H. V. Lanchester, the well-known architect and town-planning authority, and was briefly described in the Journal for January 11th. Opposition to the St. Paul's Bridge scheme is being kept alive by the Royal Institute of British Architects and three other architectural bodies. Last week support was sought, apparently not too successfully, from the metropolitan members of Parliament. A Bill promoted by the London County Council seeking authority to rebuild Lambeth Bridge came before a select committee of the House of Lords last week. The proposed bridge would have five steel arches faced with granite and resting on granite piers. Its width between the parapets would be 60ft. Considerable opposition to the scheme was expressed by a gas company, an electric supply company, the Metropolitan Water Board and the Port of London Authority.

High-speed Motor Roads.

By the introduction of a Bill in the House of Commons last week, the proposals for the construction of high-speed motor roadways, concerning which a good deal was heard a little time ago, have been carried one step nearer realisation. In asking leave to introduce the Bill, Sir Leslie Scott said that the Coventry-Salford roadway was the only scheme at present definitely projected. That road would, in its construction, employ some 40,000 persons for two or three years, and would involve an estimated expenditure of £6,126,000. With the toll fixed at one farthing per ton per mile the profits, it was thought, would be sufficient to pay a fixed interest on half the capital sum, and dividends of 2, 4 and 7 per cent. in 1928, 1929 and 1930 respectively on the other half of the capital. Those behind the scheme included men like Lord Montagu of Beaulieu, with expert knowledge of roads and engineering, and firms such as Armstrong, Whitworth, who had had practical experience of road construction. The Bill introduced by Sir Leslie is of a general nature. It does not relate to the Coventry-Salford or any other roadway in particular, but is intended to provide a simple, quick and economical method of securing the necessary powers for the construction of such motor ways in any part of the country. A clause in the Bill provides that, at any time, a motor-way may be taken over by the Government for public ownership.

The London Terminal Aerodrome.

Although Imperial Airways, Limited, is still at variance with its pilots and mechanics, with the result that no British continental air services are being run, the improvement of Croydon Aerodrome is being actively begun. The Air Ministry is spending a quarter of a million sterling on the work with the object of making the aerodrome the finest air terminus in the world. All the existing buildings are to be pulled down, and in their place there will be erected huge new flight sheds, Customs houses, waiting rooms, bonded warehouses and a hotel. These buildings will stand in the centre of the aerodrome, and round them arrival and departure platforms will be arranged in the form of a complete circle. Passengers arriving from London by motor car or electric train will reach their departure platforms by means of subways. It is anticipated that before the end of next year passenger air expresses will each day leave for and arrive from every city of importance in Europe and Northern Africa. The sites for the new flight sheds have been marked out, and it is hoped to begin building operations almost at once.

Agricultural Machinery Research.

It is announced that the Ministry of Agriculture will set up an Agricultural Engineering Research Institute at Oxford, which will carry on its work in connection with Oxford University. The University has, we learn, chosen Captain B. J. Owen as the first Director of the new Institute. This appointment is a happy one, since for some time past Captain Owen has closely identified himself with the machinery research work which has been carried on by the Ministry. We are given to understand that while the responsibility for research and investigation will be assumed by the University, it is still the intention of the Ministry of Agriculture to establish and carry out a scheme for testing implements. The proposal is that tests should be made and certificates issued by the Ministry, the actual testing operations being conducted at the new Oxford Institute and also at the National Physical Laboratory and other institutions. Appropriate fees for testing machines are to be charged, and it may be expected that the implement testing scheme will be able to be run on a self-supporting basis.

The Mauretania.

Elsewhere in the present issue an account is given of the interesting work of reconditioning the turbine machinery of the famous Cunarder Mauretania. Her passage from Southampton to Cherbourg during the week-end proved an exciting and perilous experience, for during the greater part of a fifty-six-hour journey she was in danger of being driven on to the French coast. When she slipped her moorings at Southampton and left the Solent in tow of five powerful Dutch tugs, there was a north-east wind blowing and a fair crossing was expected. But heavy weather and winds were encountered during Friday and Saturday, and Captain Rostron decided to remain out at sea in order that any danger of running aground might be avoided. The towing speed of 5 knots was therefore reduced to 1 knot, and Cherbourg Roads were safely reached late on Sunday afternoon. Later on the Mauretania was dry-docked in the Homet Basin, which again was a delicate operation, since the width of the dock is only some 10ft. in excess of that of the liner. In addition to skilled workmen from Messrs. Thornycrofts', the services of a large number of French fitters and labourers have been requisitioned, and it is hoped that the vessel will be again in a condition to take up her Atlantic sailings in a little over a month's time.

Double-Acting Marine Oil Engines.

The present year will probably be known as the year of the double-acting marine oil engine. At the end of last week important bench trials of the new double-acting engine designed and built at the North British Diesel Engine Works, Whiteinch, Glasgow, were run, we understand, with conspicuous success. These trials consisted of a nine-day non-stop run, during which period the engine developed 1940 brake horse-power at a speed of 94 revolutions per minute. The fuel used during the trials was a heavy Anglo-Mexican boiler oil of 0.96 specific gravity, and a consumption of from 0.448 lb. to 0.5 lb. of fuel per brake horse-power hour was registered. The amount of lubricating oil used varied from 10 to 12 gallons per day of twenty-four hours. The engine also ran excellently, we are informed, with an overload of 10 per cent. We have already described this double-acting two-stroke cycle sliding-cylinder engine. It has three cylinders, each 24½in. diameter by 44in. stroke, and is designed to develop 2000 brake horse-power at 100 revolutions per minute. On the Tyne another double-acting engine has recently run its preliminary trials. This engine is of the Werkspoor direct double-acting four-stroke cycle type, and has been developed by the North-Eastern Marine Engineering Company, Limited, in conjunction with Werkspoor, of Amsterdam. It is a single-cylinder experimental unit of about 1000 brake horse-power capacity, and during the preliminary trials it developed 800 brake horse-power when running at 95 revolutions per minute. In general design the new engine has many features closely resembling those of the marine reciprocating steam engine. The starting and manœuvring operations are confined to the top of the piston, and the underside of the piston is switched in after it has been warmed up by the exhaust gases. Provision is made for examining the piston without breaking the cover joint or raising the cylinder cover. Further fuel consumption tests are shortly to be run.

A Powerful British Locomotive.

We learn that the London and North-Eastern Railway Company has placed an order for an exceptionally powerful main-line locomotive with Beyer, Peacock and Co., Limited, of Gorton Foundry, Manchester. It is understood that the new engine will be of the Garratt patented articulated type, which comprises two locomotives with one common boiler. The design has been specially made in order to meet the arduous service conditions of the railway company's Worsborough line. This line is a mineral traffic line, and between Wombwell and Penistone it has in the past often proved necessary to attach several locomotives to one train. With the new Garratt engine, considerable economy of working is expected. The following are some of the principal dimensions of the new engine:—Total wheel base 77ft. 6in.; grate area, 56ft.; total tractive effort, 62,650 lb.; with a total weight in working order of 163 tons. The engine will have four cylinders, each of 21in. diameter, and a piston stroke of 26in. Considerable interest attaches to this engine, which, we believe, will be the first of its type to be built for British main-line service. The builders have, we understand, given an undertaking to complete the locomotive in as short a time as possible.

London's Electricity.

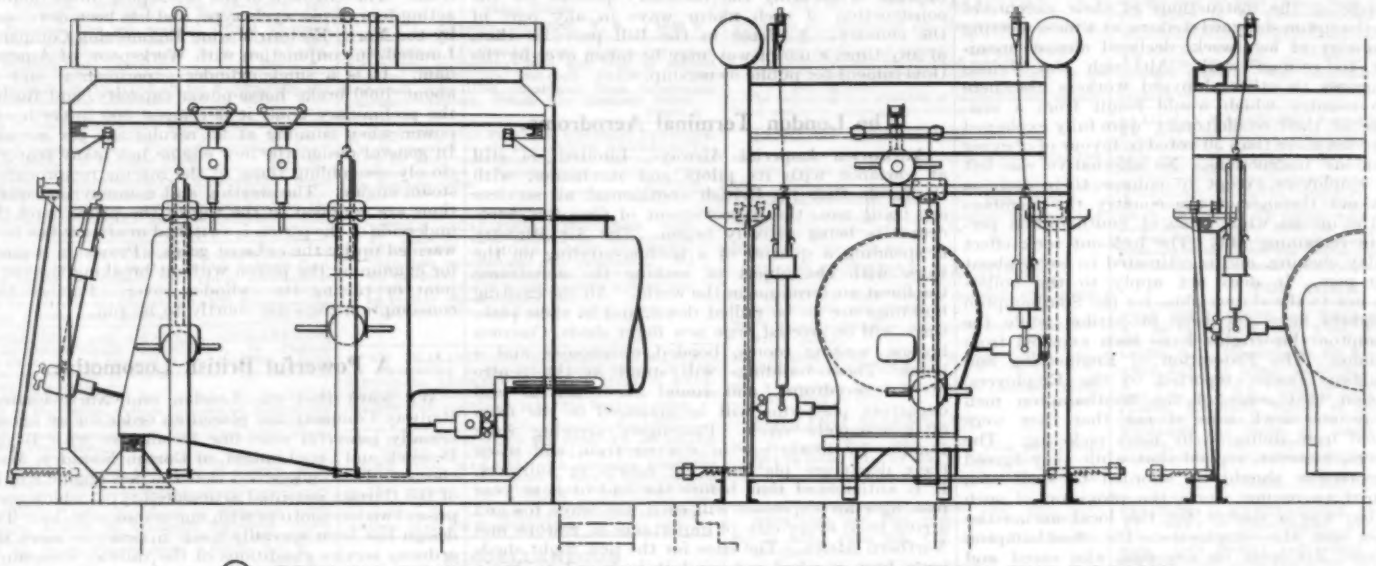
The Electricity Commissioners have just issued a new draft order covering the London and Home Counties Joint Electricity District and incorporating the London and Home Counties Joint Electricity Authority. Commenting on the subject, the London County Council special electricity supply committee states that it is hoped that it may be possible for an order setting up a joint electricity authority for Greater London to be approved by the Minister of Transport and confirmed by both Houses during the present session of Parliament and possibly by the end of June. The representation accorded to the London companies has been reduced by four, and that of the local authorities owning undertakings has been correspondingly increased, the number of publicly elected members now being 21 out of a total membership of 27. A feature of the settlement will be the regulation, in accordance with a sliding scale, of the prices which may be charged by the London companies for electricity and the dividends payable by them.

The Stability of Passenger Ships.

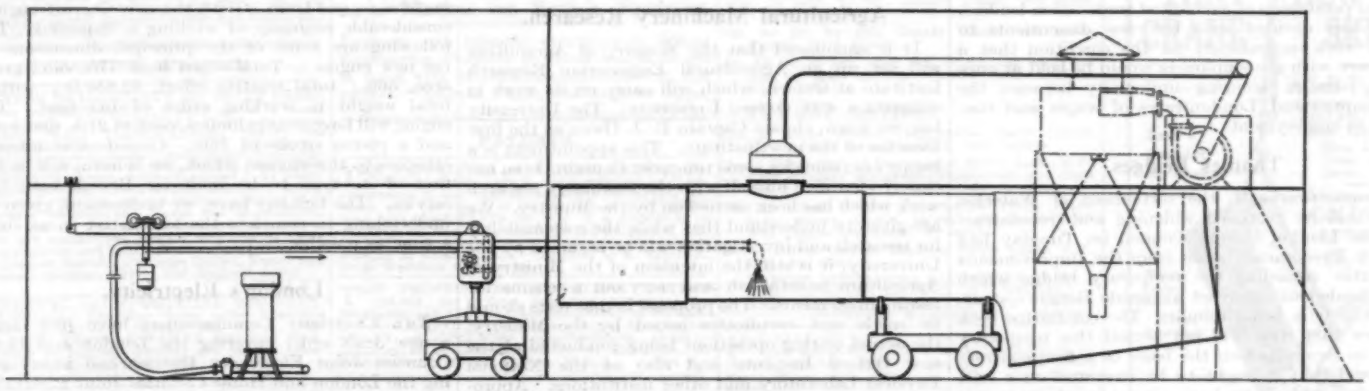
In our issue of September 14th, 1923, we gave a description of the system of bulges and anti-rolling tanks employed on the 20,000-ton liner Albert Ballin, owned by the Hamburg American Line. It will be remembered that some 60ft. of the 400ft. bulge on each side of the hull was used to form three anti-rolling tanks, separated from each other by wash bulkheads in order to restrict the motion of the water in a longitudinal direction. The lower part of each tank was furnished with elongated slots or wash ports communicating with the sea, and the corresponding pairs of tanks on either side of the ship were interconnected by an upper air passage furnished with air-control valves, so that the period of oscillation of the water in the tanks could be easily controlled. Sea-going experience with the vessel has shown that she is comparatively free from rolling under normal sea conditions. Some rolling was, however, experienced during a recent voyage when the ship was deeply loaded and was sailing with a following wind and sea, and we learn that the designers are of opinion that the size of wash ports in the anti-rolling tanks were too small to permit of a sufficient release of water to effect the maximum damping out of the rolling movement. In the recently completed 22,000-ton sister ship, the Deutschland, the area of the wash ports has been considerably increased, and the results obtained with this modification will be watched with interest. It is hoped to obtain comparative figures for the two ships.

STAGES IN THE RECONDITIONING OF LOCOMOTIVE BOILERS

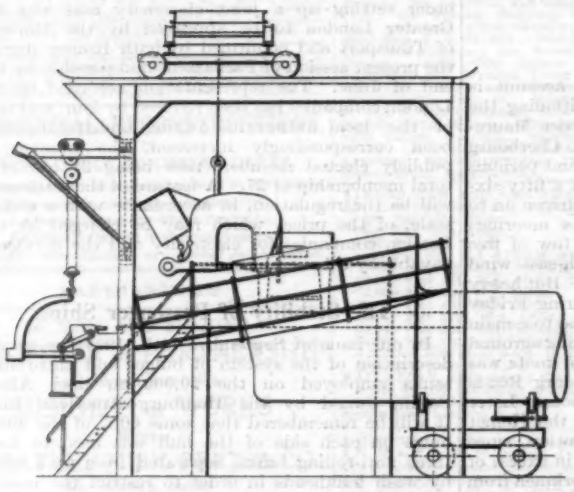
(For description see opposite page)



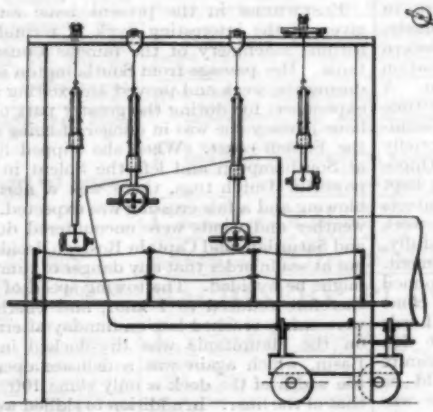
Ⓐ DRILLING STAYBOLTS AND CROWN STAYS FOR DISMANTLING THE FIREBOX



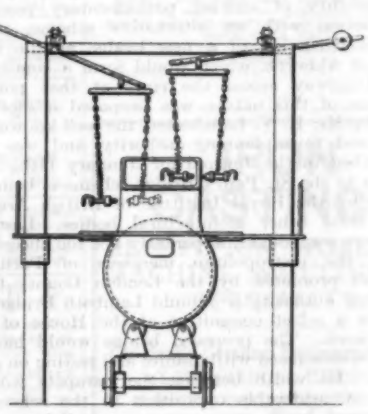
Ⓑ SAND BLAST PLANT FOR CLEANING INSIDES OF BOILERS



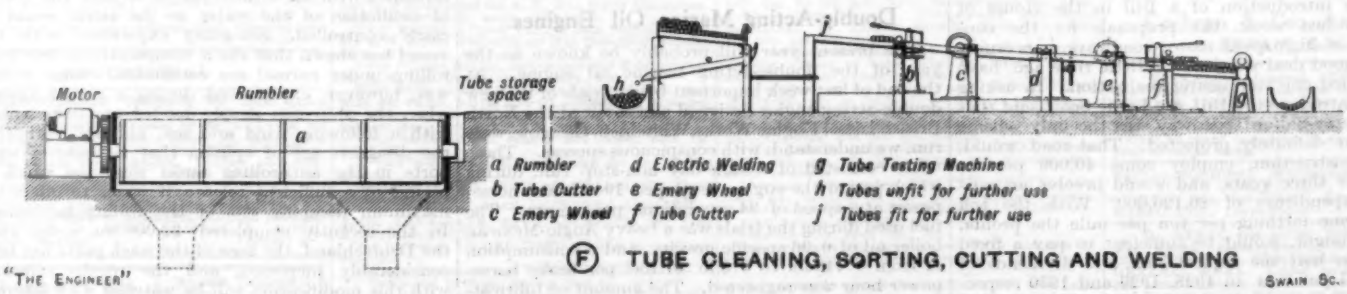
Ⓒ RIVETING FIREBOX FOUNDATION AND DOOR RINGS, AND CAULKING PLATES



Ⓓ REAMING AND THREADING STAYBOLT HOLES



Ⓔ RIVETING STAYBOLTS



a Rumbler *d* Electric Welding *g* Tube Testing Machine
b Tube Cutter *e* Emery Wheel *h* Tubes unfit for further use
c Emery Wheel *f* Tube Cutter *j* Tubes fit for further use

Ⓕ TUBE CLEANING, SORTING, CUTTING AND WELDING

"THE ENGINEER" SWAIN Sc.

A Modern Locomotive Boiler Reconditioning Shop, Alsace-Lorraine Railway.

By J. T. BURTON-ALEXANDER.

ON a recent visit to Strasburg I was enabled to visit the new boiler shop of the Alsace-Lorraine Railway, which has been built since the Peace Treaty gave back to France the two provinces. It was built and equipped because the then existing facilities for boiler renewals were either not up to date or were insufficient in capacity to deal with the arrears which had accumulated through the war, and with the necessary replacement of steel fire-boxes—of which there were 750 in bad condition—by copper boxes.

In laying out the shop modern practice was followed, and the dominant idea was the "Straight Line" system with fixed stations for the various stages of the work, towards which boilers and material would be automatically directed, enabling each part of the work to be done by the most suitable and labour-saving tools, and in such conditions that the workmen produced the maximum of work with the minimum of physical effort.

Bischeim, close to Strasburg, where repair works already existed, was chosen for the shop, which has been built in reinforced concrete, with a central nave 492ft. long, 65½ wide, with two side bays of the same length, and 26ft. wide. Illumination is obtained by top and side lights and is excellent even in dark winter days. The central nave is provided with two travelling cranes of 30 and 5 tons respectively, and the side bays by 3-ton cranes, one for one bay and two for the other. The central nave is kept for repairs, dismounting the damaged parts, mounting the new parts, making good erosion and wear by electric welding, testing the boilers, and flanging the plates with a 600-ton press after heating in an oil furnace. The side bays are kept for making new fire-boxes and parts such as boiler-barrel rings, tube plates, and ashpans, and for executing tube and superheater repairs and the grinding and fitting of the various cocks, &c.; while the external sheeting of the boiler is done in the erecting shop.

When an engine comes in for either a new fire-box or heavy boiler repairs, it is first of all drawn by a capstan under a cradle, fitted with electric winches which lift it and place it on a truck which enables it to be hauled to the new boiler shop.

Having reached the boiler shop the lay-out of the work is as follows—see Fig. 1.

(1) Removing the boiler from the frame.

(2) Drilling the stay bolts and crown stays for dismantling the fire-box, cutting the rivets and removing parts which are to be changed—see drawing A, page 404.

(3) Cutting the stay bolts and knocking out the rivets, and dismantling such parts of the fire-box as are to be renewed.

(4) Removing those parts of the stay bolts and crown stays which are screwed in the fire-box shell.

(5) Scouring the boiler—see drawing B, page 404.

(6) General repairs to the boiler, repairing erosion by electric welding.

(7) Remounting the fire-box.

(8) Riveting the fire-box foundation ring and the fire-box door ring and caulking the plates—see drawing C, page 404, and Fig. 2.

(9) Reaming and threading the stay bolt holes—see drawing D, page 404, and Fig. 3.

(10) Screwing in the stay bolts.

(11) Riveting the stay bolts—see drawing E, page 404, and the lower engraving on page 414.

(12) Tapping the crown stay holes, screwing in the crown stays, fixing the cocks, &c., and re-tubing.

(13) Cold and steam tests of boiler.

As explained, operation No. 1—Fig. 1—is done outside close to the old erecting shop. When finished, the boiler is placed for operation No. 2 on a special truck, on which it remains till operation No. 5. The intermediate operations are all carried out on the same line of shop railway, but No. 5 is done in another shed outside the new building. After No. 5 the boiler is returned, still on its truck, to station No. 6, where it is lifted and left for the repairs mentioned above. After these repairs, the boiler, which is ready to receive the fire-box, is lifted by the travelling crane and placed on another truck, upside down, at No. 7, where the fire-box is put in place. For operations, Nos. 8 to 12 the same truck is used, and no use is made of the travelling crane. After No. 12 the travelling crane places the boiler on the test pit No. 13, from whence it returns to No. 1 for its re-erection on the frame.

A description in more detail of each step is interesting, as the use of some of the tools is not usual:—

Operation No. 2.—The quickest way to dismount a fire-box, completely or partially, is to drill into the stay bolts in the shell of the fire-box a hole of the thickness of the plate. The stay bolt may then be broken by a pneumatic hammer. The cradle or staging—see drawing A, page 404, and Fig. 4—enables this drilling to be done very rapidly. It is a frame completely surrounding the fire-box shell; the sides and back are fitted with vertical guides, which are adjustable, for supporting the pneumatic and electric drills. The top of the cradle is also fitted with supports for two drills for the vertical crown stays. The pneumatic drills are counterbalanced, and a piston fitted to the drill and worked by compressed air gives a steady pressure. The same device is also fitted to the drills for the crown stays. Eight men can drill at the same time, and seven hours are taken upon a boiler with 1200 stay bolts and 190 crown stays. A pit under the cradle, piped for acetylene and oxygen, enables two workmen to cut out the foundation ring rivets.

Operation No. 3. *Breaking the Stay Bolts.*—This operation is rapidly performed by two or three blows of a punch with a pneumatic air gun, provided the hole in the stay bolt has been stopped at the depth of the inside of the plates; the plates fall into a pit and are subsequently removed. The threaded part of the stay bolt which remains in the plate is removed by hand or by a pneumatic chisel.

Operation No. 5.—The scouring of the boiler and fire-box shells is done by a sand blast, similar to that used in foundries—see drawing B, page 404. A tube is introduced from the smoke-box end and is rotated as it is moved forward, so that the sand blast proceeding from it reaches every part of the boiler and fire-box shell. A vacuum aspirator draws the scale and sand dust into a separator. The use of coarse silicate sand effects this scouring very quickly and leaves all the plates clean and ready for inspection and any building-up that may be necessary as a result of corrosion.

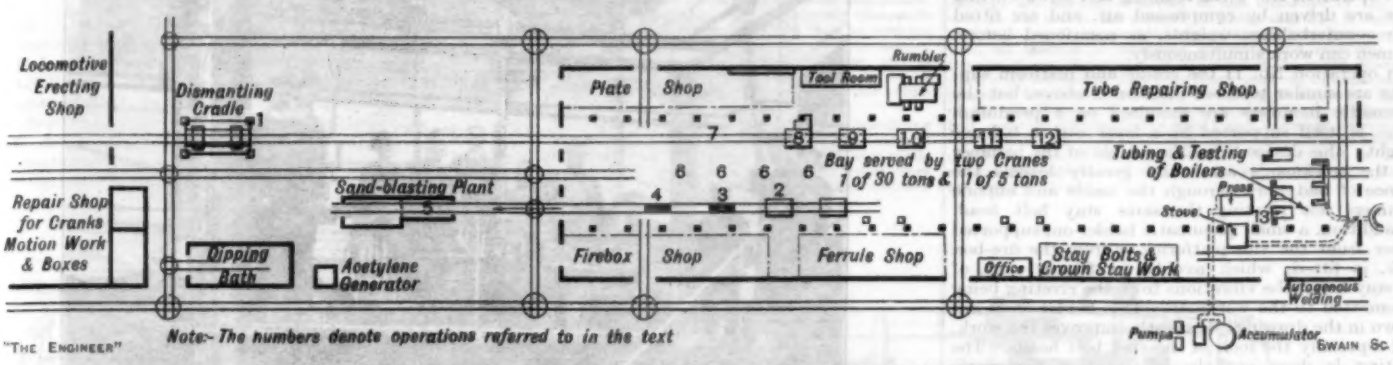


FIG. 1—PLAN OF LOCOMOTIVE BOILER RECONDITIONING WORKS AT BISCHEIM

Amongst the operations under the heading No. 6 the following are the most noteworthy:—

(1) The use of a portable oil furnace and a small hammer worked by compressed air for quickly drawing down the ends or corners of the various plates.

(2) The process for putting bushes in the holes of the stay bolts, worn too large for standard stay bolts, is as follows:—Steel bars of suitable diameter are threaded in lengths of 50 cm. to 1 m., and on a cutting-off machine are cut to lengths slightly above the thickness of the plate. They are then drilled with a hole 23 mm. in diameter, and screwed into the stay bolt holes which have been previously tapped. A conical punch, driven by a pneumatic hammer, makes such a perfect joint of the screw threads that no caulking is necessary.

Operation No. 7 is greatly facilitated if a solid platform, enabling the men to work at a convenient height, is provided. The drilling of the holes in the new fire-box, after the foundation ring has been placed and the setting out of the fire-box with regard to the fire-box shell has been done, only takes from

FIG. 2—RIVETING THE FIRE-BOX FOUNDATION AND DOOR RINGS

4 to 5 hours. The cradle is similar to that in use for operation No. 2.

Operation No. 8.—The cradles used here—see drawing D, page 404—and in the subsequent stages, have the following features in common:—The platforms on which the men work can be lowered and raised by winches fixed on the vertical columns. Fixed stairs are arranged on the sides, which give access to the platforms, which are fitted with safety rails and are of such a width that the men are entirely at their ease. The rivets are heated in an electric furnace placed at the side of the cradle at the right height to be passed directly to the riveters.

In operation No. 9 the reaming and screw-cutting tools are driven by compressed air, and are fitted with counterbalance weights, as mentioned before. Six men can work simultaneously.

In operation No. 11 the cradle and platform supports are similar to those mentioned above, but the pneumatic hammers are mounted on a pendulum which is itself supported by a lever with a balance weight; this device takes the weight of the hammer off the workman's arms and greatly lessens the chance of bad work through the inside and outside hammers not riveting the same stay bolt head. In addition, a small pneumatic holder-on, supported either from the side platforms or from the fire-box shell, is fitted, which avoids, in 90 per cent. of the stay bolts, the vibrations from the riveting being transmitted to the workman. This holder-on is not shown in the drawing. It greatly improves the work, and especially the look of the stay bolt heads. The riveting is done entirely by rotating pneumatic hammers, and the two heads of the stay bolt are riveted simultaneously.

Operation No. 12.—The boiler, which was upside down, is now turned so as to enable the holes of the crown stays to be tapped. This is done, as well as their screwing in, on a special platform, close to the tool which cuts the thread on the crown stays.

The tubes and the various valves and cocks having been dealt with and repaired in the side bay specially reserved for this purpose, now arrive at this station and are fitted; the tubes are expanded by an electric tool furnished with a limiter, which prevents undue stress on the tube plates.

The boiler is now ready for its steam test, and is placed over a pit giving easy access to the fire-box shell. The smoke is drawn out by a chimney fitted with a Chanard ventilator.

Repairs to the Tubes.

The installation for the repair of tubes presents some new features, which we propose to describe, as they do away with much handling and labour. The repairs of the tubes, if electric welding is used for fitting new ends, include the following processes:—

(1) Cleaning.
(2) Verification and straightening.
(3) Cutting one end.
(4) Grinding to ensure the contact with the jaws of the electric welding machine.
(5) Welding.
(6) Grinding the burr left by the weld.
(7) Cutting the end.
(8) Testing.
(9) Jumping-up the end of the tube—smoke-box end.
(10) Reducing the end of the tube—fire-box end.

Advantage has been taken of the circular section of the tubes in operations 1 to 8 to allow them to roll from one stage to another. Drawing F, page 404, and the upper half tone engraving on page 414 show the arrangement by which the tubes roll from one machine to another on two parallel inclined rails.

An ejector, which is worked by compressed air and controlled by foot, takes the tube at the bottom of an inclined plane and allows it to fall into a trough which is placed exactly at the height at which it must be cut, ground, welded, &c. All the workman has to do, without leaving his place, is to extend his left hand and take the tube, drawing it along the rollers in the bottom of the trough till it is in the position for working on it. This operation finished, the workman pushes back the tube into the trough and with his foot works a second ejector, which places the tube on the next inclined plane and so on.

The following are the principal tools employed for the operations as numbered:—

No. 1.—The rumblers in use are slightly different from those in most French railway works. They are opened by taking away a part of the cylindrical shell, thus allowing a transporter to put in and take out the batch of tubes at one operation. These rumblers are fitted in a pit completely buried and covered, which so reduces the noise that it has been possible to place them in the shop itself.

No. 2.—The tubes taken out of the rumblers in lots of 100 to 120 for those of 50 mm. diameter, are placed on the first inclined plane and examined singly. Those which are no further good are thrown out, *h*; those which can be used are placed on the second inclined plane at *j*, which leads to operation No. 3.

No. 3.—The cutting off of the end is done by an ordinary tube cutter.

No. 4. *Grinding.*—This is necessary to ensure a good contact between the jaws of the welder and the tube, and is effected by an ordinary emery wheel.

No. 5.—The welding is more akin to that by arc than to that by resistance. In welding by resistance the parts to be welded are brought together progressively, as the metal softens under the heat disengaged by the current. In welding the tubes, they are brought together and then slightly drawn apart till a small arc is formed. This arc, accompanied by much sparking, rapidly extends over the entire periphery of the tube which is brought to a white welding heat in about 12 seconds for a tube of 45 mm. to 50 mm. At this moment the current is cut off and the jaws are immediately approached so as to force together the extremities of the two tubes. This method entails only very local heating, restricted to the parts to be welded, and the expenditure of current is very small.

For a tube of 45 mm. to 50 mm. the current used during the 14 seconds that the operation lasts does not exceed a consumption of 8 kilowatts, but should the ends be brought too close before cutting off the current, the current used will be 20 kilowatts or more, the same amount as in a weld by resistance. This low consumption of current is normal when it is realised that the part heated does not exceed 1 cm. in width on each tube, and that 180 calories are sufficient to bring 1 kilo. of iron to welding heat.

The consumption of current for an hourly output of

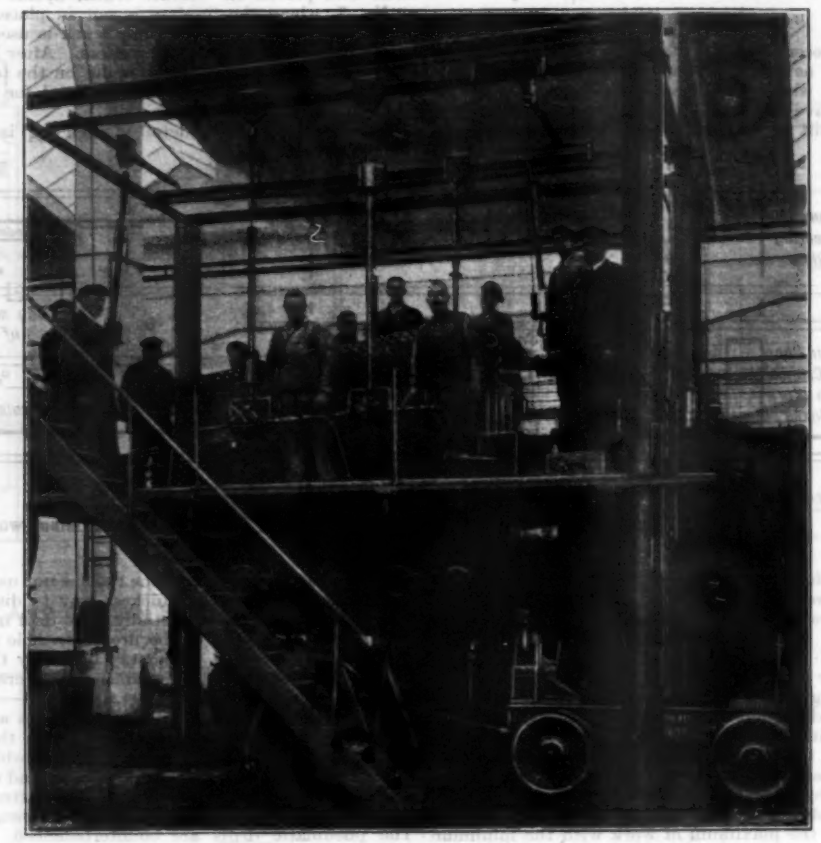


FIG. 3—REAMING AND THREADING STAY BOLT HOLES

FIG. 4—DRILLING HOLES IN STAY BOLTS PRIOR TO CUTTING THEM OUT

sixty tubes, 45 mm. to 50 mm., barely exceeds 3 kilowatts per hour, and the price of each weld is only 7 to 8 centimes as against 30 centimes for an acetylene weld.

No. 6.—This operation is necessary on account of the slight burr left by the welding, both inside and out. The burr is ground off the outside, otherwise the tube would not pass through the smoke-box tube plate; that in the inside of the tube is left, and is quickly burnt out in running.

No. 7.—This is the same as No. 3, and could be done by that machine, which would entail returning the tube and turning it, which would complicate the work.

No. 8.—The machine—Fig. 5—for testing the tubes combines several interesting features.

(1) A differential piston enables a testing pressure of 426 lb. per square inch to be attained with a pressure of 85 lb. per square inch in the air pipe of the shop.

(2) An arrangement allows the movable head automatically to hold the tube at a moderate pressure during the filling and with an increased one during the test at the full pressure of 426 lb. per square inch.

(3) A distributing four-way cock enables the four following operations to be performed by simply turning:—(*a*) Holding the tube at reduced pressure; (*b*) filling with water at the shop main pressure; (*c*) shutting off the water, applying the full testing pressure and increasing the pressure for holding the tube; and (*d*) releasing the tube and emptying it of water.

This organisation might be criticised as a repair shop, since enough work would not be coming forward regularly to keep the fixed stations and gangs busy. That is, however, more than compensated by the advantage gained by having the proper tools ready for each process, and by enabling each gang to work under physical conditions which do not entail unnecessary fatigue. In case of slack work the foremen easily find useful work for the men. In actual practice, the boiler of a standard eight-coupled goods engine is completely overhauled and renewed in 120 working hours.

The best proof that the principle is satisfactory is that the same scheme is being put into practice in all the companies' repair shops as rapidly as possible. The use of fixed cradles or staging in shops where travelling cranes are in use has two important advantages. The pipes for compressed air are fixed on these cradles and so avoid any littering of the floor of the shop, and in the same way the electric wires are in nobody's way, and lights can be fixed to the cradles in the most advantageous way.

I must thank Monsieur Renevey, Ingénieur en Chef, Matériel et Traction, and Monsieur Oudet, Ingénieur en Chef du Matériel, for the information, blue prints and photographs which have enabled this article to be written.

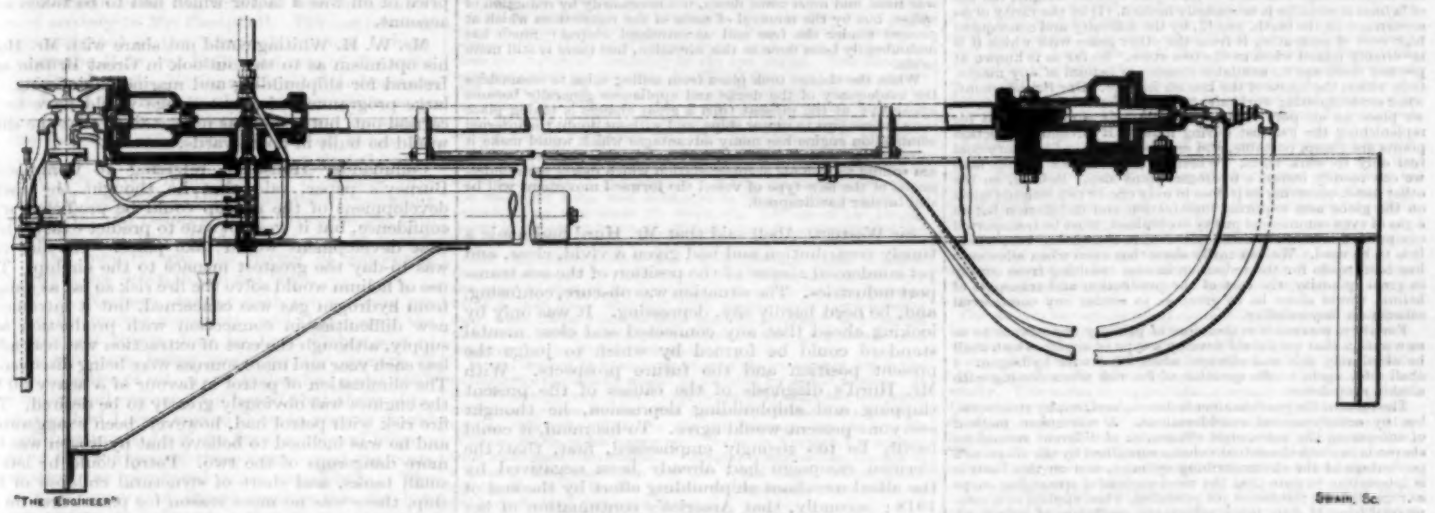


FIG. 5—TUBE TESTING MACHINE

Institution of Naval Architects.

No. II.*

THE opening session of the three meetings arranged for April 10th was devoted to a group of three papers. Mr. Archibald Hurd made a contribution dealing with "The Future of Sea Transport," Commander C. D. Burney read a paper on "The Development of the Airship, with special reference to Transport," and Sir Alfred Read gave a short address on "Sea-borne Coastal Trade." Abridgments of these papers are given below.

SEA TRANSPORT.

It is open to doubt whether at any previous period the conditions of shipbuilding and marine engineering and ship operating have been as complicated and confusing as they are at this moment. In the first place, the events at sea during the four and a-half years of war have left their deep mark on these closely associated industries. In the second place, during this period of organised violence man's conquest of the air was completed in circumstances creditable not merely to the physicist and his collaborators in the workshop, but even more creditable to the men of the new air profession, who made so conspicuous a contribution to the eventual victory of the Allies; many people are still thinking in terms of air-power, with a consequent depreciatory attitude towards all forms of sea power. And in the third place, something like a revolution in the means of propelling ships of the sea has begun.

It is, perhaps, hardly realised how greatly the Washington Treaty served the interests of the taxpayers generally, to the injury of all concerned in the production of naval armaments, one of our most important industries, employing thousands of skilled men. In the ten years before the war an average of upwards of £12,000,000 annually was spent in this country on the construction of British and foreign warships, and at least 75 per cent. of that expenditure went in wages, or an amount of not less than £9,000,000, even on the pre-war valuation of the pound sterling.

It was in these circumstances that the slump in shipbuilding and marine engineering occurred, immediately the large amount of tonnage which had been lost during the war had been made good. On the one hand, practically no warship orders were given out, apart from two battleships laid down in accordance with the terms of the Washington Treaty; and, on the other, there was little or no demand for merchant tonnage. Shipowners were confronted with the fact that, while the production of goods throughout the world was only 70 to 80 per cent. of what it had been before the war, there was a surplus of carrying capacity on the seas amounting, in round figures, to 15,500,000 gross tons, as compared with the pre-war fleets. That excess almost exactly corresponded to the losses of preceding years; in other words, the war losses were replaced by twice as much new tonnage.

Whatever may be thought of the policy which obliged the Germans to surrender their merchant fleets, it is incontrovertible that the Germans were encouraged thereby to devote themselves with great determination to the rebuilding of their merchant fleet on a higher standard of operating efficiency. This task, with the assistance of heavy subsidies from the Government, has already been carried some way towards completion. With the tonnage which has been purchased abroad, the German mercantile marine has already obtained vessels not far short of 3,000,000 tons. Hence the possibility must not be ignored that Germany will once again be the most serious rival of this country in shipbuilding and marine engineering as well as in sea transport. Already the German flag is to be seen in all the seas and oceans and in every port.

What, then, is the outlook for shipbuilding and marine engineering in Great Britain and Northern Ireland, bearing in mind the competing power of the Germans for foreign orders? It is apparent that under the most favourable circumstances we can never find employment for all the workers now in the allied industries in view of the great expansion of facilities which took place under the pressure of the submarine campaign. That involves a policy of scrapping, and not, unhappily, of plant only. It may be suggested, in view of all the circumstances, that we shall be fortunate if we are able to maintain an average output of approximately 1,000,000 gross tons a year in future, or, in other words, half the output of 1920 and about three-fourths of the average output before the war. What is to happen eventually to the surplus labour which was drawn into these industries immediately after the conclusion of the war must be a matter of grave concern, not only to shipbuilders and marine engineers, but also to the Government, since the responsibility of the State for making provision for the maintenance of its industrious citizens, as well as apparently the "work-shy," is receiving ever-increased recognition. In this respect the Americans could show us the way, as other industries there have apparently absorbed all the post-war surplus of the shipyards—a matter of many thousand men. Our trade union system in this respect is not, however, very helpful. Labour in this country is no longer fluid, and we have excess in one trade and shortage in another without the possibility of such adjustments as can be made in the United States and were usual in this country in the past.

Turning to the second consideration, it may be argued that the conquest of the air by man, in its reaction on shipbuilding, must not be ignored in any attempt to forecast the outlook of shipbuilding and marine engineering. The progress which is made by civil aviation, inevitably slow and restricted, will depend upon a scale of subsidies such as have never been provided in any country in the past for the development of commercial sea power. It is an error entertained by many foreigners that British merchant shipping, although it is not protected even in the coastal trade, receives in the ocean trades subventions from the State, open or concealed. As we all know, with the exception of the contract with the Cunard Company which was concluded a good many years ago, mainly for the purpose of regaining the blue ribbon of the Atlantic, and providing the Navy with auxiliary merchant cruisers, British shipping has enjoyed no favours of any kind from the State in modern times. Shipping has undergone a series of evolutions, testing the vision of shipowners and involving great destruction of capital, as, for instance, when steam power replaced sail power. But private enterprise has had to shoulder its burdens, not only without State assistance, but even in face of State discouragement from time to time. If the same rigid economic principles were to be applied to air power, we should have to abandon even the limited hope of slow but steady development which physical laws permit us to entertain in view of the restricted weight-carrying capacity of air power. Nor can we ignore the possibility that it will not be until a new generation has sprung up that the air travel habit will be acquired by sufficiently large numbers of people in the British Empire to encourage an expansion of the Imperial Air Services.

In glancing forward and endeavouring to forecast the conditions in which transport between nations will be conducted, we should be on our guard against assuming that the ship designer, the shipbuilder, and marine engineer have reached the limits of progress. The aeroplane and the airship of the future must be compared with the sea ship of the future. Great changes are already occurring in the character of the fuel used at sea and in the manner in which that fuel is used, as well as in ship design, and in the appliances of maritime navigation, all tending to increased efficiency and economy. On the eve of war, 9 per cent. of the ships of the world depended upon sails for power, just over 3 per cent. on oil, and rather less than 90 per cent. on coal. According to the latest figures of Lloyd's Register the sail tonnage has decreased by one-half, and that half includes a good many American ships which will probably never again be seen at sea; oil is used in upwards of 26 per cent. of the ships, under boilers or with internal-combustion engines, and coal has steadily declined as a power-raising agent at sea.

Owing to the influence of oil fuel on the British mercantile marine, ships will be in port for shorter periods, and consequently will be able to carry more cargoes and earn more profits. These considerations, it may be suggested, are to some extent balanced by the unpleasant fact that, while we possess enormous coal measures still waiting exploitation, we have in this country no oil supplies of much importance, but are dependent upon the importation of overseas supplies, most of which are not even under British control. But, in fact, we have oil in our coalfields. That coal can be distilled at a low temperature has been proved scientifically by the Fuel Research Board, and economically its practical application to no small part of our annual recovery of coal will be hastened by any tendency of oil prices to rise. It is the relative cheapness of all kinds of oil, and the high cost of labour involved in any process of coal distillation, which are checking this most important development.

The British shipowner, in spite of the economies offered by the motor ship, and the evidence that the motor ship can earn profits in moving ocean-borne commerce where the cargo-carrying steamer incurs only losses, hesitated for some time to turn from the steam engine to the motor. This hesitation was probably due, in large measure, to doubt as to the rate of depreciation of the motor ship as compared with the steamer. In that respect, evidence is now accumulating, and Swedish shipowners, in particular, have had opportunities of studying this problem as well as the problem of repair costs. As an observer who studies such developments, I would suggest that, whatever disadvantages in these respects the motor ship may have had over the steamer, the time is not far distant when it will be established that the motor ship in most conditions of sea transport is, first, and last, the most economical cargo-carrier viewed from every standpoint.

It may be suggested that in the development of the motor ship lies the hope of the shipbuilding and marine industries of this country. At the moment a greater tonnage of motor ships is in hand in this country than in all the other shipyards of the world—a matter surely of good omen to shipbuilders and marine engineers and a proof of the foresight and courage of shipowners.

In view of all these circumstances—first, the absence of a surplus of tonnage in the British mercantile marine above the normal requirements; secondly, the limited sphere of commercial usefulness of the airship and the aeroplane; and thirdly, the advent of the motor ship—I would suggest that the outlook for the shipbuilding and marine engineering industries in this country is full of promise. We are the heirs of great traditions of ship design, ship construction, and ship engining as well as ship management, and we possess a body of incomparable seamen, as the late war proved to be the admiration of the world. Competition will no doubt be fierce, both as it affects the shipbuilder and the marine engineer, and as it affects also the shipowner, or, rather, to employ a more correct term, the ship manager, representing hundreds and even thousands of thrifty investors. The necessity must, no doubt, be faced of scrapping the least-efficient shipyard plant, bringing the facilities back to something less than pre-war level, and scrapping also the least efficient workers, who came into the industry after the demobilisation of the war workers. But these twin processes will be governed by the law of the survival of the fittest, and for the rest the prospects of the industries rest in establishing cordial relations between masters and men in order that a combined effort may be made to increase the rate of production and reduce costs, for only by these means can foreign orders be obtained. We have in the past included ships among our most profitable exports—in 1913 ships built to foreign order represented an expenditure of no less than £11,000,000. The shipbuilding industry in this country has always relied to an extent which is hardly appreciated by the general public, nor apparently by trade union leaders, on orders placed by foreign customers, impressed by the quality of the work done in this country and the low prices at which ships of high quality can be obtained. Surveying the whole

* No. I. appeared April 11th.

field, therefore, the outlook for sea transport, in its reaction upon the allied marine industries of this country, is hopeful.

THE DEVELOPMENT OF THE AIRSHIP.

The differences between water-borne, particularly submarine and air-borne vessels are essentially quantitative rather than qualitative, but the quantitative differences are so great as to introduce immense difficulties before a successful air-borne vessel can be produced.

To take an example, the displacement of, say, 1000 cubic feet of sea water will result in a gross upward lift of some 28.5 tons, whilst the displacement of an equal volume of air under standard conditions of pressure and temperature at the lowest safe flying levels produces a gross lift of only 66 lb. In other words, the gross lift per unit of displacement at the service of the naval architect is nearly one thousand times greater than that at the service of the aeronautical engineer.

Hydrogen has remained for many years the only suitable means of obtaining the required displacement; but much attention has recently been drawn to the use of helium for this purpose on account of its inert properties. An airship filled with helium has a lift 7 per cent. less than one of equal displacement filled with hydrogen. This loss of lift would mean a loss in potential earning capacity of no less than £84,000 per annum in airships of the size which we shall use on the Indian route, for it should be noted that the use of helium does not result in a corresponding decrease in the structural or deadweight of the ship, even in ships specifically designed to use this gas. Apart, however, from the disadvantage attached to its higher specific weight, the use of helium in airships is necessarily limited, (1) by the rarity of its occurrence on the earth, and (2) by the difficulty and consequent high cost of separating it from the other gases with which it is invariably mixed when in the free state. So far as is known at present there are no available sources of helium of any magnitude within the limits of the British Empire. One further point, when contemplating world air routes, it is essential that wherever we place an air port we must have ample supplies of gas for replenishing the gas lost during flight. Hydrogen production plants are cheap, portable, and require supplies of ordinary coal fuel only to work them. Wherever we erect an airship base we can readily install a hydrogen plant also. Helium, on the other hand, occurring as it does in only one or two isolated spots on the globe and requiring liquefaction and distillation before a gas of even commercial purity is obtained, must be transported compressed into heavy steel cylinders to the airship base where it is to be used. We can easily show that even when allowance has been made for the reduction in cost resulting from supply in great quantity, the cost of the production and transport of helium would alone be so great as to render any commercial scheme an impossibility.

For these reasons it is therefore of primary importance to us as a nation that we should develop a type of airship which shall be absolutely safe and efficient when filled with hydrogen. I shall refer again to the question of fire risk when dealing with airship propulsion.

The form of the gas container is determined, not by structural, but by aerodynamical considerations. A convenient method of comparing the volumetric efficiencies of different streamline shapes is to state the actual volume contained by the shape as a percentage of the circumscribing cylinder, and on this basis it is interesting to note that the most successful streamline shape as regards head resistance yet produced, when applied to a commercial form of ship, has a volumetric coefficient of only 0.52. Our researches into the commercial possibilities of the airship have led us to conclude that the earning capacity of an airship increases more rapidly with increase of volumetric efficiency than does the cost of propulsion at equal speeds. This increase appears to reach a limiting value when the volumetric coefficient is about 0.62, and it is approximately upon this figure that the design of most modern airships is based.

It is now generally admitted that in the larger sizes of ship the rigid principle is the only practicable one that has yet been devised, and apart from some experimental designs carried out by English engineers prior to 1917, the system developed at the Zeppelin works in Germany has been the only one used. This system has many disadvantages, the resultant structure is exceedingly complex and redundant, and the side loading on the longitudinal girders quickly reaches a magnitude which in ships of sizes such as are proposed to-day becomes almost prohibitive.

Designers in England have, however, long been aware of this defect of the Zeppelin system, and prolonged research has resulted in the perfection of a system for containing the gas-bag, whereby no transverse loading is imposed on the longitudinal girders and the lift of the gas-bag is collected and transferred to the transverse frames direct.

So great are the improvements that we have made both in the analysis of applied forces and in the structure required to resist them that it is possible for us to construct a modern commercial airship in which the factors of safety under the worst possible loading conditions shall not drop below a minimum value of 4, while maintaining to the full the lightness which is necessary for commercial efficiency. A rigid airship is no longer a flimsy collection of fabric and wires, but a robust structure capable of withstanding the roughest handling.

The improvements recently made in the design of streamline forms fortunately act in such a way as to render the enormously increased dynamic moments of far less consequence to the designer than would at first sight appear, and in addition enable us to attain the high speeds necessary for commercial operation with approximately only 75 per cent. of the horse-power which would have been required three years ago.

This leads me to the third problem of the means of propulsion to be adopted. Much damage has been done to the airship cause in the public mind by the outcry against the use of hydrogen, consequent upon recent disastrous accidents in this and other countries. I cannot too strongly emphasise the point that in all cases it has been definitely established that the source of fire in airships, as in heavier-than-air craft, is petrol and not hydrogen. Once we can eliminate the use of petrol as a prime mover we can render all types of aircraft, and in especial the airship, immune from any risk of fire, even supposing the ship to be involved in a serious accident. The disadvantages inherent in the heavy oil fuel engine have hitherto been so great as to render its use in aircraft impracticable, but these disadvantages have been due entirely to the high temperature cycle on which such engines operate. Now a means is at our disposal whereby a heavy oil, such as kerosene, with high flash point may be used on a low temperature cycle without loss of efficiency. The resulting engine has a weight of some 6 lb. per brake horse-power and is comparable in its mechanical simplicity and reliability with the marine steam engine of to-day. Further experiments are now in hand, with a view to using still heavier oils, such as the crude oil which is burnt in oil-fired boilers of marine type, and I think I may confidently say that the petrol age, for the airship in particular and indeed for aircraft in general, has now virtually passed, and we are entering upon an age when heavy oil fuels will be used without exception.

SEA-BORNE COASTAL TRADE.

One of the greatest difficulties which the coaster has to face to-day is the tidal restrictions. In the larger ports many hours are wasted in entering or leaving the dock waiting for the tide. The big deep-water locks are attached to the docks used by the foreign steamers, and if these are to be made use of by the small coaster, it is necessary for them to make their way through the docks either to or from their berths. This is a very tedious and slow task, and the time saved is so small it is almost in all cases better to wait for the tide. This is a handicap which neither railways nor road transport have to contend with.

In the pre-war years, 1910–14, the average coasting tonnage entered with cargoes in Great Britain amounted to almost 22,000,000 tons net. During the first post-war year, 1919, the figure had fallen to a little more than 10,000,000 tons, less than half. Great Britain is more favourably situated for extending its coastwise shipping than any other European country, but how to extend or even to get back to the pre-war conditions is a question which the coastwise shipowners have to face. Many, if not all, of the steamers operating to-day in the purely coastal trade are of the same speed as those which were running ten or fifteen years ago; but it is obviously useless to contemplate building vessels capable of accomplishing 15 knots at sea if time lost in port owing to the obsolete machinery and labour restrictions reduces the working speed to, say, 10 knots.

One of the chief things to help a trade revival, and one which must of necessity play an important part, is cheap and efficient transport; to obtain it the coasting trade must be developed, for which the co-operation of the harbour and port authorities is required. Even to-day, with very few exceptions, the accommodation and facilities at our ports are inadequate and hopelessly out of date, modern appliances for the rapid handling of cargo being conspicuous by their absence. Shed accommodation at many of the ports is of a very poor description, mainly consisting of merely single-storied wooden erections. What are required are double-storey sheds with raised platforms to facilitate the loading and unloading of vehicles, with chutes and other mechanical devices for the economic handling of cargoes. Working and running costs are still high compared with those of pre-war time, and must come down, not necessarily by reduction of wages, but by the removal of some of the restrictions which at present hinder the free and unrestrained output; much has undoubtedly been done in this direction, but there is still more to do.

When the change took place from sailing ships to steamships the inadequacy of the docks and appliances generally became apparent; at the present time a great change is taking place from steamships to motor ships, and without doubt the internal combustion engine has many advantages which would make it suitable for coastal services, but unless the port authorities are willing to provide accommodation which meets the requirements of the new type of vessel the forward movement will be still further handicapped.

Sir Westcott Abell said that Mr. Hurd had made a timely contribution and had given a vivid, clear, and yet condensed *résumé* of the position of the sea transport industries. The situation was obscure, confusing, and, he need hardly say, depressing. It was only by looking ahead that any connected and clear mental standard could be formed by which to judge the present position and the future prospects. With Mr. Hurd's diagnosis of the causes of the present shipping and shipbuilding depression, he thought everyone present would agree. To his mind, it could hardly be too strongly emphasised, first, that the German campaign had already been negatived by the allied merchant shipbuilding effort by the end of 1918; secondly, that America's continuation of her huge shipbuilding programme—undertaken, it was only fair to say, in response to our own appeals—was totally unjustified by any peace-time standard of economics; and, thirdly, that the Versailles Treaty, applied by mulcting Germany of practically the whole of her overseas fleet and allowing her to build new vessels, was not only presenting her with a ten-year start in the merchant ship efficiency race, but was at the same time handicapping allied, and particularly British, ship operators in that race by hanging a 4,000,000-ton weight of old ships round their necks. It was most interesting to study Mr. Hurd's remarks on the future relations between air power and merchant shipping. In transportation of all kinds there was an inverse ratio between increase of speed and carrying power. If the sole competitive value of aircraft lay in high speed, air machines could never hope to carry, economically, the 5000, 10,000 and 20,000-ton loads of the modern cargo liner. If there was one direction more than another in which aircraft were likely to prove of paramount value, it was as naval scouting auxiliaries. The days when a naval commander's vision was limited to the horizon of his destroyer screen were gone for ever. Scouting aeroplanes could give him an almost unbounded radius, and if the fighting navy existed to protect the merchant fleet, the protection must be adequate for the needs. Mr. Hurd had drawn attention to the possibility of a revolution in marine propulsion by the use of oil fuel, more particularly in association with the internal combustion engine. Oil fuel and the motor ship were certainly making great strides, and he personally was of opinion that very big developments were to be anticipated in the near future. There were, however, two points which to some extent modified the optimistic views expressed in the paper. The statement was made that a pound of oil would carry a quantity of goods three times as far as a pound of coal. Mr. Hurd also said that the motor ship achieved great economies in operation. While not disputing the possibilities in that direction, it would be well to point out that such economies were directly dependent on the price of oil fuel. Roughly speaking, unless the price of oil was under four times the price of coal, no great economy could result. The author also stated that with the use of oil fuel, ships would be in port for shorter periods, and would therefore carry more cargoes and earn more profits. Such an argument must be specious to some extent, since there was only a certain volume of world trade, and the ultimate effect of shorter periods in port must be to reduce the number of vessels employed. He wondered whether Mr. Hurd was quite correct in ascribing the hesitation of shipowners to order motor tonnage to doubts as to the rate of depreciation. It seemed to him that by far the more serious doubt, and one which still required to be dissipated in many quarters, was as to the reliability of the internal combustion engine. With that doubt removed, there seemed no reason why the motor ship should not become the cargo carrier of the future. He heartily endorsed Mr. Hurd's conclusion that in the development of the motor ship lay the hope of the shipbuilding industry of the country.

Sir Archibald Denny could not agree in the suggestion that the Germans had taken the lead in research work. They were very patient in analysis and willing to take any amount of trouble, but the German research workers lacked the imagination which was so strongly marked in our own investigators, and was perhaps even more strongly in evidence among French scientists. On the subject of the internal combustion engine for marine service, he would remind the meeting that in the United States proposals had been put forward for spending 25 million dollars in the conversion of steam ships into motor ships. American marine engineers had visited Great Britain to ascertain the latest developments in connection with the marine oil engine, and they had reached the conclusion that British engineers had done more during recent years to improve the design than those of any other country. The motor ship was making rapid headway, but, as Sir Westcott Abell had said, the price of oil was a factor which had to be taken into account.

Mr. W. H. Whiting could not share with Mr. Hurd his optimism as to the outlook in Great Britain and Ireland for shipbuilding and marine engineering. A large programme of new tonnage would have to be carried out, but there was no certainty that the ships would be built in home yards.

Commander Hunsaker, referring to Commander Burney's paper, said that he thought the useful development of the airship could be predicted with confidence, but it was not safe to predict exactly how that development would take place. The fire risk was to-day the greatest menace to the airship. The use of helium would solve the fire risk so far as danger from hydrogen gas was concerned, but it introduced new difficulties in connection with production and supply, although the cost of extraction was becoming less each year and more sources were being discovered. The elimination of petrol in favour of a heavy oil for the engines was obviously greatly to be desired. The fire risk with petrol had, however, been exaggerated, and he was inclined to believe that hydrogen was the more dangerous of the two. Petrol could be left in small tanks, and short of structural collapse of the ship, there was no more reason for petrol fires on an airship than in a modern motor car. On the other hand, hydrogen was contained in enormous bags, more or less contaminated with air, and ready not only to burn, but to detonate under certain circumstances. It seemed appropriate at the present time, when a monument to those who lost their lives in the R 38 was being unveiled, that mention should be made of the late Mr. C. R. Campbell. Mr. Campbell brought to the airship problem the very full equipment of a naval architect, and making the best use possible of the meagre and often conflicting information and experience available to him, designed R 38 as a war measure to answer the Zeppelin. Conceived as a war measure, R 38 was lightly built, and probably not on the safe side. The ship was lost from a combination of structural weakness, rough handling, petrol and hydrogen risks. He hoped now that by progressive trials, using strain-meters, as fitted in the Shenandoah, to check stresses in flight; that structural weakness could be detected and corrected. A new design of transverse frame developed by Campbell for the R 38 was necessary because of the great diameter of the ship. This innovation was criticised at that time. It was a satisfaction to his friends to observe that the Zeppelin Company of Germany in its latest airship, Z R 3 for America, had adopted the Campbell frame.

Wing Commander Cave-Brown-Cave raised the question of the relative advantages in connection with the fuel economy of the airship of discharging hydrogen, as the fuel was consumed to obtain equilibrium or of recovering the water. He thought the latter method preferable. On the subject of the use of helium and the fire risk, public opinion had to be taken into account. Personally, he agreed with those who regarded the fire risk as mainly bound up with the use of petrol. The only other source of fire was lightning, and in the two cases of which he had experience, no serious damage was done. In the case of the English airship which was struck by lightning when moored to the mast at Pulham, nobody who went through that experience would ever be very nervous about the fire risk from lightning. If the public insisted on the use of helium in place of hydrogen, commercial airship transport would be killed. In any event, there were great difficulties to be faced, and unless designers were allowed time to deal with all the questions which must arise, the risk of accident would be considerable. Reference was, for example, made in the paper to an engine which had a weight of 5 lb. per horse-power, and was comparable with the marine steam engine of to-day. He doubted whether that engine had ever been in the air. An airship of 5,000,000 cubic feet displacement which was going to be sufficiently reliable to carry passengers to India at a speed of 80 miles an hour, was an ambitious project, but it would not be achieved by minimising difficulties. When it was realised there would be every reason to congratulate Commander Burney and those associated with him on the

biggest step yet made in aeronautical engineering.

Mr. S. Payne referred to one or two of the more technical points raised by Commander Burney. The paper suggested that hydrogen plants were cheap, portable and only required supplies of ordinary coal fuel. He (Mr. Payne) had had charge of the hydrogen plant at Bedford, and the Government plants were not portable, although he agreed that the hydrogen was cheap to produce. For a portable plant, a large quantity of Silicol was required, and that had to be obtained from France. With a 5,000,000 cubic feet airship, the supply of hydrogen would be an important problem. Commander Burney referred to a system for containing the gas bag, whereby no transverse loading was imposed on the longitudinal girders. It would be of interest to point out that in R 38 Mr. Campbell used a somewhat exceptional method of reducing the load on the girders, but it was difficult to see how in a ship of 5,000,000 cubic feet capacity the load on the girders could be eliminated. The subject of the dynamic load was also referred to in the paper. He (Mr. Payne) enjoyed the confidence of Mr. Campbell, and knew that far from this aspect of airship design being neglected, it was the greatest source of anxiety to Mr. Campbell. The subject was being investigated at the National Physical Laboratory, when the R 38 was built, and two of the assistants attached to the National Physical Laboratory were on board the R 38 to obtain information as to the dynamic loading, and lost their lives. He agreed that the factor of safety should not fall below the figure of 4. There could be no question that the chief danger of fire arose from petrol. Hydrogen fires could be and had been extinguished before assuming a serious form. In rising a lot of hydrogen got into the corridors, and that danger must not be underrated. The remedy was the fitting of automatic safety valves low down in the gas bags.

Mr. W. H. Narbeth, dealing with the growing use of oil fuel for marine transport, said that one of the most important things done by Lord Fisher was to insist on provision being made for the storage of adequate supplies of oil. Lord Fisher had great faith in the marine oil engine. He hoped that those shipowners who had Diesel engine ships in service would allow information to be given for the general advantage as to the working of these vessels and the costs of operation, as compared with steamships. The cost of maintenance of Diesel engines was far less than was generally believed, and with the improvements in design which were being brought about would, he believed, be found phenomenally low. On the subject of alternative fuels which had been raised, there were definite prospects of use being made of alcohol produced from raw materials available within the Empire, and indeed fuels of this nature were already in use in South Africa and in Australia, and had been tested in this country in motor boats. Oil could, of course, be obtained from coal, and this subject was being studied assiduously in Germany, where it had been found that by varying the process any kind of hydro-carbon fuel desired could be obtained. He would like to see a small experimental plant for investigating this aspect of the oil fuel question established at Haslar.

Mr. Archibald Hurd, in the course of a brief reply, which he will supplement in writing, said that he had been charged by one or two speakers with being too optimistic as to the future of merchant shipbuilding. He thought there were grounds for optimism, and that shipowners in Great Britain would be forced by what was being done elsewhere to lay down new motor ships sooner than might otherwise have been the case.

Commander Burney said that the question of hydrogen burning *versus* water recovery had been raised, and he would like to point out that the real reason for adopting the former method was to reduce the temperature cycle, and thus get the engine to run for long periods. That was the main object in not adopting water recovery, and the present practice would probably persist until a different type of engine was available.

At the afternoon meeting on April 10th, two papers were included in the agenda.

Mr. M. P. Payne presented the "Results of Some Rolling Experiments on Ship Models," and Sir John Biles gave an abstract of the paper by Professor K. Suyehiro, on "The Drift of Ships Caused by Rolling Among Waves." These papers are given in an abridged form below :—

ROLLING EXPERIMENTS ON SHIP MODELS.

The purpose of the present paper is to describe the results of certain rolling experiments on ship models recently made at Haslar, which it was thought would be of some general interest.

The principal object of the experiments was to compare the behaviour of the bulged and unbulged forms of vessels of the "Royal Sovereign" class as regards rolling, &c. As is generally known, the vessels were originally unbulged—*vide* Sir Eustace d'Eyncourt's paper, "Naval Construction during the War," "Transactions" of the Institution of Naval Architects, Vol. LXI.—and they were equipped with rather large bilge keels, in consequence of which, also on account of their moderate metacentric height, they proved excellent ships as regards rolling in a seaway. When some of the vessels were fitted with a bulge, it was decided to omit the bilge keels, partly from docking and partly from speed considerations, it being anticipated —as the experiments proved—that the new naked underwater form would offer more resistance to rolling than the original, and in part at least compensate for the omission of the bilge keels. Although this plan was to a considerable extent successful, it appeared after a few years' experience with these vessels, that the decrease in rolling period, which accompanied the increased metacentric height of the bulged forms, associated as it was with a lower resistance to rolling than that of the unbulged forms fitted with bilge keels, caused them on occasions to roll to larger angles than the unbulged prototype. An example taken from a report of the Commander-in-Chief of the Atlantic Fleet gives the angle of maximum roll for two bulged ships as 12½ deg. to 15 deg. each way, and of the unbulged on the same occasion as about 8 deg. each way. This suggested the desirability of fitting bilge keels to minimise the amplitude of roll, and recourse was had to model experiments in order to put the bulged ships on a par with the others as regards resistance to rolling. It will be recalled by many that attempts to omit bilge keels have been made before, notably in the case of the old "Royal Sovereign" class, which vessels, although they proved generally good sea boats, did on occasions roll heavily, so that bilge keels were subsequently fitted, with advantage to their sea behaviour.

The models were made of paraffin as usual, their scale being one-fortieth full size. Apart from bilge keels, the models were in all cases naked.

To facilitate rapid analysis of experimental results, the original automatic rolling diagrams were dealt with on the basis of freedom coefficients. The results show that the freedom coefficients are very sensitive to period, and that with the unbulged model there is a general tendency for the freedom to increase with period, as theory would lead one to expect. Both the naked bulged models, however, appear to have a minimum freedom coefficient—*i.e.*, a maximum resistance to rolling—at all angles for a period of about 2.5 seconds—*i.e.*, near the prescribed period—which it is presumed to be attributable to some sensitive action of the bulge on the rolling. At the prescribed periods, both the naked bulged forms have much less freedom than the unbulged excepting at the low angles. The Revenge form shows less freedom than the Royal Oak, but to some extent this is due to the lighter displacement of the former for the same draught. The superiority of the bulged forms is noteworthy when account is taken of their larger displacement and metacentric height compared with the unbulged, both of which qualities would in themselves tend to make for more freedom, although the larger GM., as it imposes a shorter period, confers some advantage in this respect. If the metacentric height of the unbulged form was increased to that of the bulged, the periods being also made the same, the freedom of the former would be increased by nearly 50 per cent., the superiority of the bulged form being then very great.

The observations show that, with the bilge keels as tried, the extinction for the Royal Oak, with bilge keels, is virtually the same as that of the unbulged form, that for the Revenge being a little less. Also that both vessels under consideration may, when fitted with the bilge keels as proposed, be expected to have an extinction as great as those which have always held good reputations for sea behaviour.

It was desired to have some idea of the manner in which the extinction experiments might be affected by ahead motion. It is, of course, a very general experience that ships roll less when under steam than at rest, and some experimental results confirming this were given—for the old Revenge—by the late Sir William White in his paper on "Notes on Further Experience with First-class Battleships."* Similar confirmation, though of a more striking character, was also found about twenty years ago by Mr. R. E. Froude in some rolling experiments made on the torpedo-boat destroyer Star.

The effect of headway on the rolling of the present model, when fitted with bilge keels, is much less impressive and almost negligible at the large angles, where the extinction without headway is so large. It becomes, however, very apparent at the smaller angles, and the extinction is almost doubled in amount at 2 deg. or so, at a speed of 20 knots, compared with at rest. A slight increase of freedom at 10 knots was found for both the bulged and unbulged forms, which seems suggestive of an anomaly, but it is considered it may be dismissed and regarded as an experimental error rather than a genuine feature, the freedom being so small.

The effect of headway is relatively much more marked in the unbulged form than in the bulged form, but the latter is still, as before, more extinctive than the former, although at small angles it appears to be at a slight disadvantage. The extinction of both forms, however, is then so large compared with the at rest experiments, that this small difference may be disregarded. With bilge keels there is very little to choose between the two forms, at all angles, speed for speed.

An adequate experimental investigation into the subject of rolling amongst waves, even as far as this is practicable in a tank, would necessarily be rather lengthy. The experiments actually made were of very limited scope, as, owing to pressure of other work, their restriction was a primary consideration. For the most part the experiments were confined to the simplest case of a model square athwart the tank, and the waves, as usual, propagated along its length.

Considering first the naked model, it was found that the rolling consists of an alternate building up and dying down in a fairly regular sequence, the periodic time of the amplitude change increasing markedly with increase of period towards synchronism. Near synchronism, the rolling had generally to be stopped, as the angle of roll exceeded 20 deg. or so, with the risk of gunwale getting awash, also of carrying away the apparatus. There was a tendency for the unbulged form to more rapidly build up to these—for the model—dangerous angles, but the superiority of the bulged forms was not very decided except near synchronism, and even so quite large angles were obtained with these forms. For the unbulged form at the prescribed period, owing to the impossibility of approaching synchronism, the small slope when the wave period was a maximum was never sufficient to produce any considerable rolling.

The advantage of bilge keels shown by the experiments in waves is no less marked than in the still-water experiments. With the bilge keels fitted, apart from the lower wave periods, the envelope curves show that the rolling very soon built up to a small constant angle, the periodic changes of amplitude associated with the naked model being almost eliminated. The maximum angle of roll obtained near synchronism was never more than 7 deg., as against 20 deg. or more with the naked models, and was very regular for any given wave period.

The salient features of the results of all the wave experiments appear to be :—

(*a*) The marked sensitiveness of the rolling motion to wave period near synchronism with the naked models, and the effective damping of this roll which results from the bilge keels, it not being found possible to roll the models fitted with bilge keels to large angles under any of the conditions tried.

(*b*) The additional resistance to rolling of the naked bulged form, as found by the still-water experiments, compared with the naked unbulged form, although of service in restricting the amplitude of roll amongst waves, is not sufficient to prevent heavy rolling when near synchronism.

(*c*) When the rolling period is well removed from synchronism the rolling is very moderate in all cases.

(*d*) Steep waves of comparatively small period—about 1½ sec. —distress the models to a marked extent by imposing large heaving oscillations, generally slightly more marked in the bulged forms.

(*e*) A point of interest is that the mean period of roll amongst uniform waves was found to be virtually the same as the wave period over the range of wave periods tried—1.5 sec. to 2.8 sec.

(*f*) A question was raised as to whether the bulges help the water, in a sea-way, to mount the deck. Observations were made during the rolling experiments amongst waves, but under these conditions—which, of course, may well be different to those obtaining at sea—this tendency was not evident. So far as these experiments go, it would appear probable that any excess of wetness associated with the bulged forms is directly incidental to their heavier rolling, and if this could be prevented the wetness would also be diminished.

The paper is accompanied by very complete tables and curves.

* "Transactions," I.N.A., Vol. XXXVI.

DRIFT OF SHIPS CAUSED BY ROLLING.

The complicated motions experienced by a ship on waves seem to be of a purely oscillatory nature, and no non-oscillatory component is represented in them. In reality, however, a non-oscillatory component—namely, the yawing to one direction or the other—which is induced by the forced oscillations among waves, is intermingled in them. This fact was ascertained by the author and communicated to the Institution.*

On further investigation the author has found that there is another non-oscillatory motion in the form of drift associated with rolling among waves. The object of the present paper is to show the nature of the drift caused by the rolling. This motion resembles the yawing motion observed by the author in that both of them are the secondary effect of the oscillations among waves, although the probable causes inducing them seem to be absolutely different. As described, the drift seems to occur owing to the direct action of waves on the ship rolling among them, whilst the yawing is caused by the combined action of rolling and pitching, that is to say, an indirect effect of the waves.

The author measured experimentally the mean drifting forces of two ship models and, applying the law of comparison, calculated the drifting force on a vessel 310ft. long with a displacement of 5290 tons. He finds that the probable drifting force induced by synchronous rolling will be as strong as that caused by a side wind of an intensity corresponding to a moderate breeze. Judging from this, it may be inferred that, when a ship is tossed about by storm waves, she will very likely be subjected to an enormous drifting force.

Although the phenomenon has not been investigated for the simple reason that the waves generally progress along with the wind, and thus a discrimination of the causes giving rise to drift is impracticable, yet it may not be without interest to shipbuilders and navigators to know that waves alone induce the drift of a ship through her rolling.

Remembering that yawing is induced as a combined effect of rolling and pitching, an anti-rolling device of one sort or another seems to be necessary to protect a ship against yawing and drifting and to keep her on a straight course in a rough sea.

The second part of the paper deals with the orbital motion of the centre of gravity of ships rolling among waves, and from observations made the author concludes that a ship rolling among waves will be subjected to a side pressure which gives rise to drift as well as the peculiar orbital motion of the centre of gravity. This seems to suggest that a certain correction, though of secondary importance, is necessary for the ordinary equation of rolling, especially for the case of synchronous rolling, of a ship having her centre of gravity high above the water line. Without further investigation, however, the author is not in a position to say how such a correction should be introduced.

In opening the discussion, Sir John Biles said that he desired to express his appreciation of Mr. Payne's paper, and to say how much that contribution to the "Transactions" of the Institution reminded him of the work done by Dr. R. Froude, who for so many years worked in the field of research that had now been taken up by Mr. Payne.

Professor J. J. Welch dealt briefly with the paper by Professor Suyehiro. The experiments described were, he said, of an interesting character. In his investigation of rolling among waves the author had endeavoured to get what was known as the effective wave slope, and he found that in the case of synchronism the effective wave slope was principally the upper surface of the wave, whereas in cases apart from synchronism the effective wave slope passed practically through the heel. In all theoretical considerations on rolling the effective wave slope was assumed to be the upper wave surface, and it seemed that apart from synchronism the assumptions made were on the safe side. Dealing with Mr. Payne's paper, the method of analysis by means of the freedom coefficient was new to him, but what had been done gave evidence of great ingenuity combined with accuracy. It was not possible in the time at disposal to discuss many of the details of this very informative paper, but the experiments went to confirm earlier researches, and it was interesting to note that the Admiralty, having for the second time attempted to do away with bilge keels, had had to adopt them again, although it was now known that a smaller area of bilge keel would suffice. The fitting of bilge keels seemed to lengthen the period of rolling.

Mr. E. L. Attwood said that Mr. Payne's paper was a record of results in connection with rolling obtained by model experiments. He did not propose to comment at length on the paper, certainly not to criticise it. It afforded another illustration of the value of model experiments, and showed how at a relatively small cost results of the highest value could be obtained. One point of considerable practical importance suggested by these experiments, was the length of bilge keels as affecting the rolling. The original length was given as 350ft. or 60 per cent. of the length of the ship. The forward and after portions of such a bilge keel had a relatively small radius about the axis of oscillation and, therefore, were not fully effective against rolling, and would be a cause of increased resistance. In the bulged models the length of the bilge keel had been cut down to 200ft., or 35 per cent. of the length of the ship. It was manifestly in the interests of economy to limit the bilge keels to the shortest length which might be regarded as effective, and he would like to ask Mr. Payne if that point were considered in fixing the new length at 200ft., and if any preliminary experiments had been carried out with varying lengths of bilge keel to

* "Yawing of Ships Caused by Oscillation Amongst Waves," "Transactions," I.N.A., Vol. LXII. (1920).

ascertain what was the most desirable length to fit.

Mr. Lloyd Woolard said that the paper was full of information, and was one of the most important yet published on the rather neglected subject of rolling. Looking to the importance of a steady ship for gunnery, and, above all, for passengers, this neglect was surprising. Mr. Payne had done useful service, and he hoped he would continue the work and give some results with light cruisers. The paper threw light on the behaviour of bulged ships. He had only one criticism to offer. Why not plot the reciprocal of the freedom coefficient? The advantages would be approximately straight lines instead of hyperbola, and would be easier to follow. Those interested might refer to Mr. John's paper of 1907 for clear analysis of forces, &c. In connection with rolling among waves, he noted that the synchronising wave had a period at least of 16 seconds, and would point out that such waves were very rare, and they had little height-length ratio. Only the extreme left side of Figs. 17–24 was of interest, therefore, when dealing with big ships. Referring to these figures, the non-agreement between theory and result was very interesting. One would expect the maximum angle recorded to agree with "criterion amplitude" defined by Mr. R. E. Froude.

Mr. G. Vedeler said that Professor Suyehiro raised the necessity of giving a certain correction to the ordinary equation of rolling among waves. The late William Froude first published his theory on the rolling of ships in 1861, and since then practically nothing had been done to revise that theory. Froude's paper of 1861 contained a remark that it would be impossible for any wave to move a ship with no metacentric height. Everybody knew now that this statement was not true. Although in some exceptional cases ships might behave well even with a negative initial metacentric height, the metacentric height alone was not a criterion of how a ship would behave at sea. Nearly two years ago he was working at this problem and succeeded in finding a solution which, although by no means gave a better idea of the problem of rolling than that of the late William Froude, his solution showed that it was not only the metacentric height, *i.e.*, the relative position of metacentric and centre of gravity which gave a measure of the behaviour of ships at sea, but that the relative position of the centre of buoyancy to the centre of gravity was of great importance. He thought the position of centre of buoyancy was a question to which attention should be called if a more thorough knowledge of the stability problem was to be gained.

Mr. W. H. Narbeth referred to practice in the design of warships to deal with the problem of rolling. The Royal Sovereign had a considerable "tumble home," and Sir William White was anxious to retain it because it diminished rolling. In the light condition the metacentric height of the Royal Sovereign was 3.2 and in the deep condition 3.7. The figures for the King Edward VII. were 5.3 and 5.4. In the Dreadnought the resistance to rolling received considerable attention. She was designed with a flat bottom, vertical sides and no "tumble home," but from the midship section forward there was a flare outwards, and the resistance to rolling was the greatest which could be obtained. He would like to point out that the "tumble home" made a wet ship.

Mr. Payne, in a short reply, said that a question had been asked as to the length and area of bilge keels in the bulged form. That was really arrived at somewhat by chance. They wished to make the bulged ship as good as the unbulged, and tests were made with fore and after end and midship section to ascertain the effect. With regard to the suggestion as to plotting the reciprocal of the freedom coefficient, that had not occurred to him. The freedom coefficient had a definite meaning which was an advantage. He was rather surprised that nobody had raised the question as to what extent the results disclosed in the paper from the model experiments had been borne out in practice. Actually there was very little information on the subject. Only one report had come under his notice, but it was satisfactory to find that as far as it went it confirmed the model work.

Reconditioning the Turbines of the s.s. Mauretania.

All who were connected with shipbuilding and engineering whilst the Mauretania and Lusitania were under construction will doubtless remember the discussions which took place regarding the reliability of Parsons turbines of the enormous size necessary to give the power required for these ships. Not a little doubt was expressed in some quarters as to the wisdom of entertaining such a proposal, or even of the practicability of carrying out such an installation, and considerable trepidation was felt in other quarters in the good sense of the Cunard Steamship Company when it decided to adopt such machinery for vessels of commercial utility. To those acquainted with the Cunard Company's history, such a decision was only in keeping with its customary enterprise in moving with the times and even leading the times. When these vessels actually came into service the public watched with interest the breaking of all existing speed records for the North Atlantic route, and the remarkable consistency of their running was favourably commented on. Even then there still was a feeling of doubt as to how long this performance would be kept up, until, as time passed, the novelty of the unusual type of machinery wore off, the war intervened and the general interest lapsed. Owing to the sad and tragic end of the Lusitania, it has been left to her sister ship the Mauretania to uphold the honours that they won together.

In the spring of 1921 this vessel was converted from coal burning to oil fuel burning, the Cunard Company being fully alive to the many advantages of oil as a fuel in a ship of this type. Although since that time she has been running with remarkable regularity at a good average speed, she has not since the conversion equalled the previous best voyage run with coal, which was an average of 26.06 knots for a single trip in September, 1910. Towards the latter end of the 1922 season some damage was sustained by the turbine blading of the low-pressure turbines. When these turbines were opened up, several blades were found to be slack and others distorted, the binding wires in a number of cases also being found broken. At this time a thorough examination of all the turbines was made to ascertain what would be required to effect a complete renovation in order to get the machinery into its original condition as far as possible. To effect this, nothing short of entirely re-blading all the turbines was anticipated in some quarters. Inspection showed, however, that nothing of that magnitude was necessary; in fact, apart from the forward ends of the turbines and one or two other isolated places, the cleanliness and general good condition of the turbines as a whole was surprising. The necessary repairs and renewals having been decided upon, the damaged rows of blading were cut out, the turbines closed up and arrangements made by the Cunard Company to lay the vessel up at the end of the 1923 season to carry out the reconditioning, the necessary material, such as new blading, dummies, sleeves and rotor forgings, being prepared in the interval.

The 1923 Turbine Repairs.

In November, 1923, the vessel was laid up in Southampton as had been arranged, and the work of opening up the turbines and carrying out the repairs was entrusted, as in the previous case, to John I. Thornycroft and Co., Limited.

A brief description of the repairs carried out, after sixteen years of practically continuous service, will doubtless be of considerable engineering interest. Towards the better understanding of the work, it should be remembered that in this ship there are four lines of shafting. A high-pressure turbine drives each of the outboard shafts and a low-pressure turbine each of the inboard shafts. Forward of the low-pressure turbines on each inboard shaft, an astern turbine is arranged, the outboard shafts not being used for astern work. The total horse-power of the four ahead turbines is about 80,000.

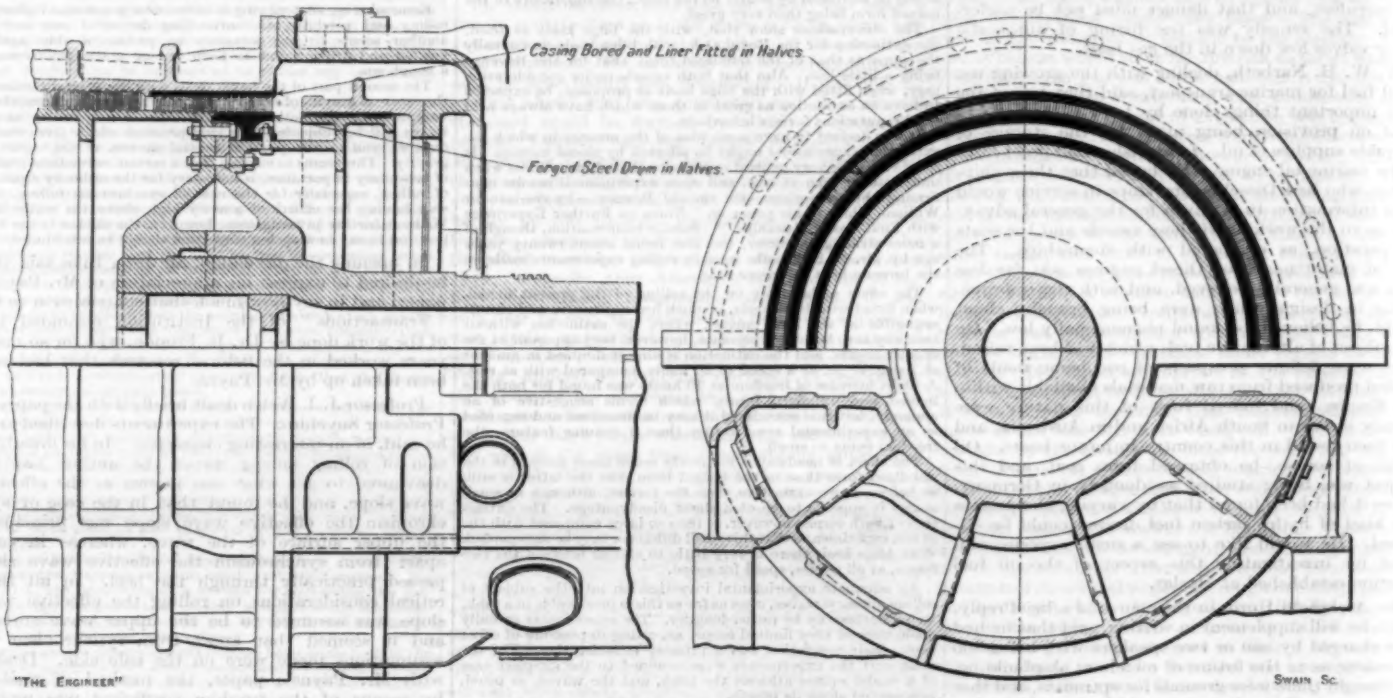


FIG. 1 REPAIRS TO THE TURBINES OF THE MAURETANIA

On opening up and examining the high-pressure turbines, it was found that active corrosion had been going on, and had extended from the turbine side of the manœuvring valves, through the steam strainers, steam belt, rotor and casing dummies and ended towards the last row of the first expansion blades. The drop in pressure at the manœuvring valves under normal conditions is about 30 lb. The fact of corrosion being active in the main steam connections in the engine-room had been, from the pressure conditions, apparent for some considerable time. About eighteen months ago, it was deemed advisable to renew certain main steam master valves in the engine-room, because of the deterioration which had occurred.

During the present overhaul, one of the turbine manœuvring valves for controlling the ahead and astern running of the inner shafts has been renewed for the same reason. Originally these valve chests were made of cast steel, but the new chests have been made of cast iron, the scantlings, of course, being increased to suit. The change of material from cast steel to cast iron was decided upon after noting the condition of certain other steam chests made of cast iron, which were found to be in practically as good a condition as when originally installed, whereas the cast steel chests had wasted away considerably.

As has already been stated, a most thorough inspection of the internal condition of all the turbines and rotors was made while the damage to the low-pressure turbine blading was being investigated. Evidence of corrosion had previously been noted when the turbines had been opened up for survey. This corrosion was confined almost entirely to the forward ends of the high-pressure turbines, and the dummies of both high-pressure and low-pressure ahead tur-

bines. To restore the high-pressure turbines, it was decided to renew entirely the dummy casings in both turbines. The dummy casings are 7ft. 10in. bore. Originally, the dummy packing strips were of the axial type, but with the fitting of new dummy casings radial fin packing strips have been adopted. This, of course, involved the removal of the original strips in the dummy pistons, and the fitting of new strips of the radial fin type. The forward ends of the turbine rotors had also suffered—a portion about 12in. long was cut off each rotor and new pieces 7ft. 11½in. in diameter fitted.

To remove the corroded portion of the cast iron turbine casings was a matter that called for careful consideration, so as not to weaken the casings unduly. The restoration of these parts has been effected by boring out the casings in way of the first expansion; that is, for a length of 2ft. 2½in. To effect the removal of all the corroded metal, the casings were machined to a bore of 8ft. 7in., the original bore being 8ft. 5½in. Steel sleeves, made in halves and 1in. thick, have been fitted to the casings to replace the corroded metal. The work referred to is illustrated by the drawing we reproduce in Fig. 1. Before any of this new work could be started, it was necessary to remove by machining in place the blading on the rotors and in the casings in way of the affected parts. The boring out of the casings for the new sleeves, the machining of the grooves in the rotor end and in the casing sleeves for the new blading—all of which had of necessity to be done in place on the ship—is an engineering accomplishment, the magnitude of which can only be realised by those who are acquainted with large marine machinery installations. The conditions under which the work had to be carried out were by no means conducive to rapid work. As there were fifteen rows of rotor blading, and the same number of rows of casing blading to be dealt with at the first expansion alone, it will be realised that the machining operations called for the exercise of much patience. The machining of the rotor by means of a fixed tool resting on the casing joint—see Fig. 2—presented no unusual difficulties after appropriate tools had been prepared. The rotor running in its own bearings was rotated by means of a motor geared to the turning gear wheel fixed at the after end of the rotor spindle. A speed of 40ft. per minute, or about 1¼ revolutions per minute, was obtained.

The machining of the casings to take the new sleeves was accomplished by attaching a specially designed tool holder to the rotor, which was turned by the motor-driven gear already referred to. The form of tool holder adopted is shown in Fig. 3. As the space between the rotor drum and the casing is only $2^{11}/_{16}$in., the job was anything but a comfortable one from the machinist's point of view. The illustration reproduced in Fig. 4 shows the form of boring head adopted for removing eight rows of casing blading foundations at the first expansion on the low-pressure rotor, and also the tool rest which was employed for machining the cylinder dummy wall and the spigot. Without the exercise of much care and not a little faith in the means adopted, irreparable damage to the casings could easily have been done. That no hitch occurred, redounds to the credit of all who directed and carried out the work. When the casings were bored, the new sleeves were machined on the outside to suit. By carefully registering the position of the rotor blades, the grooves in the internal surface of the sleeves were cut before the sleeves were fitted, thereby reducing considerably the amount of machining at the ship. The sleeves were secured to the casings by about 106 screwed pegs fitted from the inside in each turbine. Each of the fifteen rows of casing and rotor blading is built up of ten segments, which are secured in the grooves by means of special caulking strips. The fitting of the segments to the rotors and to the bottom halves of the casings was quite straightforward, compared to the blading of the top halves of the casings. This work, having to be done from below, that is, with the casing overhead, was a very awkward job.

Other work was done on the fifth expansion blading of the port high-pressure rotor where fourteen rows of blading were also renewed. In the low-pressure turbines themselves a considerable amount of re-blading work has been carried out. It includes the renewal of the blading in the first expansions, the whole of the damaged rows in the fifth expansions, both casings and rotors, and the fifth expansion of the rotors only in port and starboard turbines, altogether twenty-three rows of rotor blading and fifteen of casing blades. In the first expansion the blades are 8½in. long and two binding wires are fitted, while the sixth expansion blades are 22in. long, three binding wires being provided. Special attention has been paid to the position of the gaps in the binding wires, so as to eliminate as far as possible weakness at the joints of the segments.

As already stated, new dummy casings, 9ft. 9½in. internal diameter, were also fitted to these turbines, the packing strips being of the radial fin type. New blading has also been fitted to the sixth expansion casing and rotor of the starboard astern turbine, comprising eight rows of rotor blading and the same number of casing blades. In all the turbines dealt with, the total number of blades renewed is 132,960. Taken alone, this number appears remarkable, but when it is learned that the total number of blades in the complete turbines is 385,700, the figure does not appear so astounding.

The necessary material required for these repairs—that is, the high-pressure turbine rotor ends, casing sleeves, high-pressure and low-pressure dummy casings and all the blading—was prepared by the makers of the turbines, the Wallsend Slipway and Engineering Company, Ltd., while the machining operations at the ship and the fitting of the new parts were carried out by J. I. Thornycroft and Co., Ltd., Southampton.

No pen could adequately describe the scene in the engine-room during the repair operations. Before the turbines could be looked at, an enormous amount of dismantling of pipes, valves, gratings, ladders, &c., had to be done and space found for stowing parts removed—not a little task in itself. The work on the various turbines had of necessity to be carried on concurrently, and at times a turbine casing top half or perhaps two top halves would be suspended overhead while the work on the rotor was in progress. At other times rotors, in addition, had to be suspended to permit of work in the bottom half of the casings being carried out. To the casual observer, the chaotic scene presented would be such as to suggest that order could never be restored out of such an apparent upheaval. Certainly no pessimist could long survive in such an atmosphere. In addition to the renovation of the main turbines as described, the boilers and auxiliary machinery have been thoroughly overhauled, as well as all of the machinery in connection with the passenger accommodation. Towards the end of the time continued and serious delay was caused by the Southampton strike, and in order to complete the job it became necessary to send the ship to Cherbourg. The Mauretania left Southampton on Friday last in charge of five tugs, and after a stormy passage of 56 hours she reached Cherbourg on Sunday afternoon and was later on put into dry-dock. The work on the turbine blading will be finished by Messrs. Thornycroft's skilled engineers, several of the men having been sent over to France

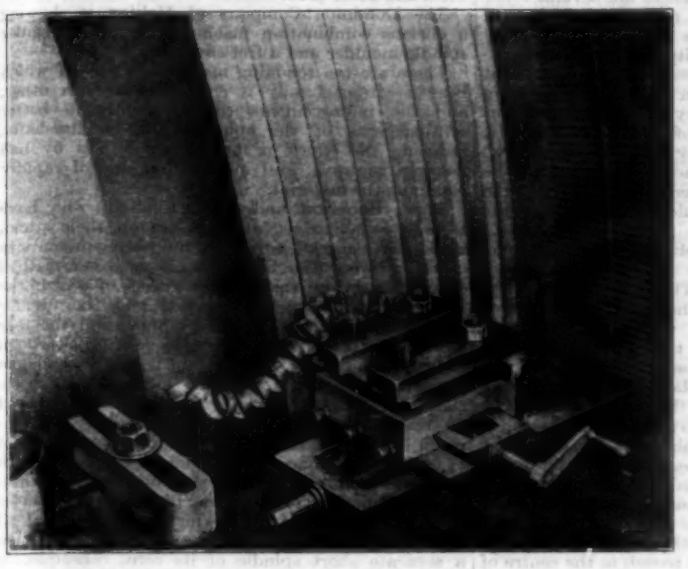


FIG. 2—MACHINING A ROTOR

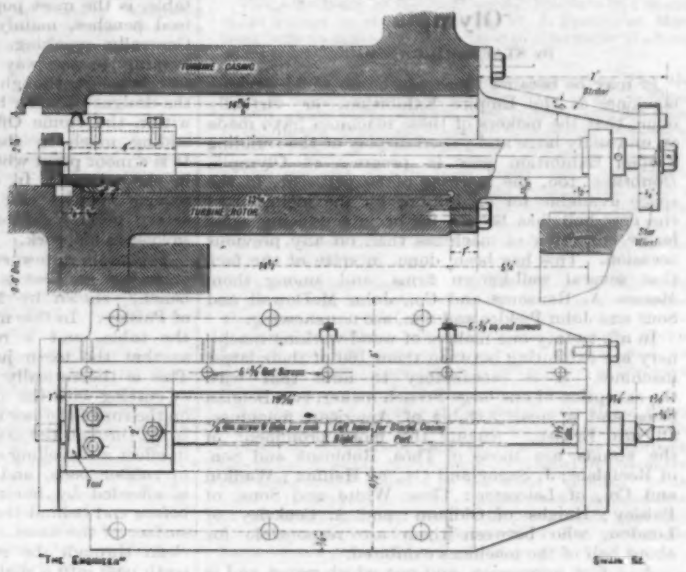


FIG. 3—TOOL HOLDER FOR BORING CASINGS

FIG. 4—BORING HEAD AND TOOL REST

for this purpose. With French assistance it is expected that from five to six weeks will be required to finish the reconditioning the ship.

Considering the extensive nature of the overhaul, the interest displayed in her performance in 1907 will no doubt now be revived. Taking all the factors into consideration, one would be quite justified in entertaining expectations of all previous speed records being equalled, if not improved upon.

Wood-working Machinery at Olympia.

By STAFFORD RANSOME.

It may be because there will be no wood-working machines at the Empire Exhibition, or virtually none, that the makers of these machines have made an unusually large and varied display at the Building Trades Exhibition now in progress at Olympia. Doubtless, too, the increase of 50 per cent. in the space available for exhibition, by the inclusion of the new hall, has been a factor in producing a far larger collection of machines than on any previous occasion. This has been done, in spite of the fact that several well-known firms, and among them Messrs. A. Ransome and Co., John McDowall and Sons and John Pickles and Son, are not showing.

In all, twenty-one makers of wood-working machinery are exhibiting between them 160 of their latest machines. It is satisfactory to note that with the exception of one large French maker, two Belgian firms and a small exhibit of American machines, all are British. Among the more prominent of the stands are those of Thos. Robinson and Son, of Rochdale; J. Sagar and Co., of Halifax; Wadkin and Co., of Leicester; Thos. White and Sons, of Paisley; Haighs of Oldham; and A. Cooksley, of London, who between them are responsible for about half of the machines exhibited.

As a first impression, and one which grows and is confirmed by a careful study of these exhibits, is the remarkable redundancy of certain of the machinery at the different stands, showing how large a number of different firms are employed on making one and the same thing. So marked is this feature that the marvel is that so many makers can possibly find a market for all these machines, especially now that so many of the foreign markets are virtually closed to them and others greatly restricted.

This redundancy is mainly to be attributed to the war, during the years of which these firms were all employed in making indiscriminately what in the past had been looked upon as the specialty of a few makers. It points also to the fact that, although a few years ago there was an endeavour to do so, these firms have not yet come to any sort of agreement between themselves to restrict their own variety in production and so reduce the overlapping to a reasonable degree.

Another pertinent and interesting fact in this Exhibition is that, while, roughly speaking, before the war there were in this country two distinct classes of makers of wood-working machines, now there are three classes. The first two above alluded to were:—(1) The larger firms who made practically everything and who sought to produce a machine which for quality, if not for price, would capture the important trade all over the available world; and (2) those who catered for the cheap trade in competition with the machines dumped in this country from America and Germany at prices lower than they were sold for in their respective countries of origin. The third and new class that has now sprung into being is a very important one, and one which is bound to affect the whole policy of the manufacture of wood-working machinery in Great Britain.

It includes the firms which, while limiting their lines to a few different types of machines, manufacture them for stock in considerable quantities at a time on standardised lines to jigs and templates. Though this method is far from new in many branches of engineering, it is distinctly so, as far as adoption on an important scale is concerned, with wood-working machinery in this country. The net result is that the firms which employ this method can offer, and are offering, a good machine at what in the past would have been regarded as a very low price. It is popularly said that the price of wood-working machines has practically doubled as compared with pre-war prices. That is by no means the case with many of the machines of the more ordinary sort shown at the Building Trades Exhibition.

The reason why manufacturing for stock was unpopular in the past was that the details in the design of wood-working machines even in the case of the ordinary general purpose types were constantly changing, and the adoption of standardised types, turned out on what one may call semi-mass production principles, might well leave the manufacturer who employed that method somewhat behind the times, unless he were to go to the expense of scrapping his jigs and altering his standards fairly frequently. In any case, this method of manufacturing wood-working machinery is a factor to be reckoned with at the present day, and it is clearly demonstrated at the Building Trades Exhibition by the very different prices which are asked by the various makers for what is virtually the same machine. As a matter of fact, there is an extraordinary variation in the qualities of some of the machines shown, but it is by no means in every case that the difference in the price is to be accounted for by a different process followed in the manufacture.

Of circular saw benches there is a great variety. Twenty-nine of them are shown, and among them there are but few of the ordinary plain bench type. Certainly, judged by its numbers, the dimension bench with two spindles, carrying a ripping and a cross-cutting blade respectively, and with canting table, is the most popular. There are several roller feed benches, mainly of the radial-arm feed type. Generally speaking, there is nothing particularly striking in the way of novelty with regard to the saw benches, though there is strong evidence that the designs of some have been altered to bring them within the Home Office safety regulations, without adding much in the way of extra attachments. It is a moot point whether they have been improved in the process. In appearance, at all events, the reverse is the case, and certainly some of the safety guards exhibited would badly hamper the sawyer in his work.

The most noteworthy novelty in the way of circular saw benches is the new "straight line edging bench," shown by Messrs. Thos. White and Son, of Paisley. In this machine the saw spindle is above the table, and is regulated vertically downwards so that the teeth just pass through the material. This is theoretically and actually the best method of cutting with the circular blade, as the work done on the rim of the saw is always the best. The material is fed through the saw on a travelling chain, which is in effect a travelling endless table made up of a series of rubber pads, and a further propelling influence is afforded by horizontal feed rollers immediately before and behind the blade and acting on the upper surface of the wood. In order that the saw may cut clean through the material the extremities of the teeth pass into a shallow lead trench in the centre of the travelling chain, perhaps ¼in. below the table level.

The travelling chain has two great advantages over any other. The first is that travelling always in a straight line parallel with the blade the straightness of the cut is no longer dependent on the adjustment of the fence. In fact, for some classes of work the fence can be dispensed with altogether. The other advantage of the chain feed is that the shortest of material can be fed through the machine without mishap or check, and one does not have to worry about the gaps between the feeding-in and feeding-out rollers where there is no propelling effect. The fence can be used indiscriminately on either side of the blade, and no part of the blade is visible, all adjustments for the cut being regulated instantaneously to a graduated scale. The feed is independent of the saw spindle, and is driven by a separate motor. The effect of this machine is to improve the quality of the work very considerably, as with a blade in proper order the edges of the boards require neither planing nor sand-papering before glueing up. Further, it increases the output approximately four times as compared with the work of the ordinary push bench edger with the saw spindle below the table.

Of the plain band saws, of which there are nine or ten, there appears to be nothing very striking in the way of improvements. There are two or three high-speed band re-saws and one band mill for logs, and a reciprocating log cross-cut saw working with a strained blade.

There are forty-three planing machines, of which sixteen are hand-feed surfacers, seven panel planers and eleven combinations of the two. Curiously the greatest variety in the design of these machines is to be noticed in the surfacing machines, which range from massive machines weighing a couple of tons or more down to a miniature bench machine, which literally can be picked up under the arm and carried about with its motor and set to work on any table without fixing as long as there is an ordinary electric light socket within range. This development of the hand-feed planer, both in its massive and small forms, is one of the most remarkable features in the show. The larger sizes have usurped almost entirely the functions of the old trying-up machine without which not long ago the builder's workshop was considered incomplete.

It is a sign of the times that there is not a single sample of the trying-up machine in this Exhibition, just as there is not a single frame saw. Another very familiar machine which seems waning in popularity is the general joiner. A few firms, it is true, are showing a combination wood-worker more or less well adapted for the same functions, but these machines are all of the simplest types, and there is not one of those elaborate four-side joiners which the medium and small builder used to swear by a few years ago.

There are no less than seventeen moulding and shaping machines for irregular surfaces. Of these, fourteen are of the single vertical spindle type, while two for shaping and recessing have the spindle overhead, and one only is of the "elephant" type with upper and lower spindles. The novelty in these machines lies mainly in the ingenuity of the various new devices for tenoning, dovetailing, housing, &c. The most interesting of these is a device shown by Messrs. Perkin and Co., of Leeds. It is an appliance by means of which any ordinary vertical spindle moulder can be made to do housing and recessing work, which has hitherto been looked upon as the prerogative of machines with an overhead spindle.

There are nine four-side planing and moulding machines, mostly of the lighter types, but Messrs. Robinson and Messrs. White are both showing high-speed machines embodying the features recommended in the articles on "High-speed Planing," which appeared in The Engineer on October 12th, 19th, and 26th, 1923.

The Dominion Company of Halifax is showing a curious combination machine, viz., an irregular spindle moulder and a fret-saw in one.

There are ten tenoning machines, many of which bear a strong family resemblance to each other, and the improvements consist mainly in better arrangements of the spindles and countershafts, reducing the effort in moving the tables by ball bearing runways, and improved means of rapidly clamping the material.

Thos. Robinson and Sons, Limited, who have a very complete set of machines on their stand, make a feature of two very interesting inventions of their own. The first is their patented method of mounting saw spindles by means of which the spindle speeds can be increased and the quality of the work improved. In this invention the rear ball bearing is carried on a steel sleeve or tube through the centre of which, and clear of it, the saw spindle passes. This sleeve projects into and supports the driving pulley, the outer boss of which is keyed on to the end of the saw spindle. This arrangement has the effect of relieving the saw spindle of the strain occasioned by the pull of the belt, which is transferred entirely to the steel bush. Thus, no matter how tight a belt may be, there is no danger of distorting the spindle, which is relieved of all but torsional stress. The loose pulley revolves on a separate short spindle of its own, consequently there is no friction on the saw spindle when the machine is not cutting.

The other invention of this firm is an improved block for hand feed and other planers. One of the difficulties and dangers of the hand-feed planer is that when any other form of block is used, cutters, especially when not quite sharp, have a rebutting effect on the material, causing it to tremble or "judder" as it passes over them, and increasing the effort required to hold it in place and effect a smooth passage. By merely cutting away a portion of the material of the block immediately behind each cutter and graduating the curve until it attains the normal circle of the block at a point further back, a tendency to create a vacuum is formed and air is caused to rush in towards the block through the gap between the tables. This simple process causes the wood to be sucked down firmly on to the table, and the operative is spared the effort of pressing it down. Thus better work is ensured, and the man using the machine has merely to propel and not to press.

Several firms are showing small bench planers and saws, and one is showing a bench band saw. These miniature machines, which, as in the case of the hand-feed planer already referred to, can be moved about anywhere with great ease, are becoming a real factor in the outfit of the small builder, the patternmaker and sawyer who has odd jobs to do. Developments in direct electrical driving are very noticeable at this Exhibition, and an interesting application of the flexible drive for boring, planing, sanding and rubbing is shown, as is also a set of machines on the lawn-mower principle, for planing, sand-papering and rubbing irregular floors, whether when new or worn.

Altogether this Exhibition shows many marked improvements in wood-working machinery. This is partly due to the fact that two years have elapsed since the last one, but it is mainly to be attributed to the fact that these particular two years have been unusually prolific in new designs, if not so much in striking and revolutionary inventions. This is because until 1922 the fictitious post-war boom had not entirely subsided, and in the slack period that followed, our manufacturers have had time to devote their energies to improving their patterns, for which there had previously been but little opportunity since 1914.

In 1913 the Lancashire and Yorkshire Railway Company obtained powers to prevent the improper use of railway carriages. Those powers have been of great use to the police. Dirty and verminous persons on the other sections of the London, Midland and Scottish Railway, who use railway carriages as sleeping places, cannot, however, be proceeded against. On the Lancashire and Yorkshire section there were, however, thirty prosecutions last year, of which twenty-nine resulted in convictions. It could not be said that there had been fewer cases of the improper use of railway carriages, but offenders could more effectively be dealt with. In its Bill now going through the House of Commons, powers for the whole of the London, Midland and Scottish system are being sought, but the Home Office requested that they should not be granted unless in the public interest. This request resulted in the Select Committee deleting the clause.

Railway Matters.

WE often see the engine that figured in the opening of the Stockton and Darlington Railway—now safely housed in the British Empire Exhibition—referred to as Locomotion No. 1. This is incorrect; its name is Locomotion, with the numeral 1 above it.

AN improvement, much appreciated by business men, has been made in the train service between Newcastle and Hull. The 12.10 p.m. express Newcastle to York goes on to Hull and returns thence to Newcastle *vid* York at 4.45. Both trains have a restaurant car.

IT was stated in this column on the 14th ult. that the Great Western Railway Company was seeking authority to abandon the scheme sanctioned by the Callington Light Railway Order of 1900 and 1909. An intimation from the Ministry of Transport on the 31st ult. shows that consent to this course has been given.

AN unusual incident occurred on the Central London Railway between the Chancery-lane and Post Office stations on the evening of the 10th inst. Some deposits of dust from the running and conductor rails and the contact shoes were set on fire, presumably by an electrical spark, and smouldered. The resultant smoke caused the officials to stop the trains until the smouldering was put out by sand.

THE Camden Town Extension, which includes six tubes and two double junctions, between Euston and Camden Town Stations on the London Electric Railways, will be opened for public traffic on Sunday next, the 20th. The tunnels of the City and South London Railway from Euston to Moorgate-street have been enlarged, and will now take a through service of trains between Hendon and Moorgate-street. The work was described in THE ENGINEER of the 14th ult.

THE much-discussed railway scheme from Valparaiso to Santiago, *vid* Casa Blanca, is once more to the fore. Experts have reported in favour of an electric railway of the same gauge as the electrified State line between Valparaiso and Santiago. The new line is to have two branches, one to connect with Mellpilla, thus shortening the distance between Valparaiso and the newly developed port of San Antonio; the second branch will run to Talagante, and join the central line to Santiago at Paine.

THE final report of the court of inquiry as to the grievances of the tram men was issued on the 11th inst. The strike being over and attention being now more concentrated on the London Traffic Board Bill, the report is of little interest. One paragraph of the report should, however, be on record in our pages. It reads: "In our view, no satisfactory and abiding solution of the difficulties of the tramways undertakings can be reached unless the tramway industry is considered in relation to the wide problem of passenger transport in London. We are also of opinion that the best interest of the public would be served if all services of passenger transport were so regulated that, instead of being largely competitive, they were complementary."

THE career of Mr. A. H. Smith, the president of the New York Central, who, as announced in these pages on March 28th, was killed when out riding, was one of those of which Samuel Smiles used to write. He started as a messenger boy when fourteen years of age on the Lake Shore and Michigan Southern—a New York Central subsidiary—and became a clerk. After five years' clerical work he recognised its limits and so entered the construction gang, and when twenty-seven was foreman of bridges. He was suddenly selected to be a divisional superintendent, and was in charge of one after another of four divisions until he was thirty-eight, when within three months he was, first, assistant general superintendent and then general superintendent. Two years later he was the general manager, and when fifty-one became the president. He was only sixty-one when he was killed.

MENTION was made in this column on March 28th of some of the benefits of the common user of railway-owned wagons. Mr. Jenkin Jones, whom we were quoting, also gave the following figures as to oil-lubricated wagons:—At June 30th, 1918, of all the London and North-Eastern wagons in common user 40 per cent. only had oil axle-boxes. By June 30th, 1923, this number had been increased to nearly 60 per cent. These figures do not include North British end-door wagons, the great majority of which are confined to working in Scotland. At the rate at which the grease axle-boxes are now falling out, it may be anticipated that in twelve years' time there will be no grease axle-boxes on the London and North-Eastern Railway. On the Southern Railway 70 per cent. of the common user wagons have oil axle-boxes, and again at the end of twelve years the grease axle-boxes will have practically disappeared. In the case of the London, Midland and Scottish Railway the percentage of wagons with oil boxes has increased from 33 in 1918 to 44 in 1923. All renewals are being fitted with oil boxes, and grease-boxes are expected to disappear within the next seven years.

JUST as the London and North-Eastern Railway Company's Bill furnished an opportunity to force that company's hands as to the electrification of the Great Eastern and Great Northern areas, so did the London, Midland and Scottish Bill, when it came up for second reading on the 1st inst., give the Southend Corporation a chance to complain that the requirement in the Midland Railway Act of 1912 to furnish, by 1914, a scheme for the electrification of the Tilbury Railway had not been complied with. Mr. H. G. Burgess, after showing how the war, Government control and grouping difficulties had delayed the preparation of the scheme, explained that his company need no longer use Fenchurch-street—which belonged to the London and North-Eastern—but could go to its own station at Broad-street or, perhaps better still, convert Haydon-square goods depôt into a passenger station. Mr. Burgess went as far as to suggest that a better service could be given with steam trains than with electric; the company wanted to give Southend the best service. He undertook, however, that the Southend Corporation should see a scheme by September 30th next, in time to be embodied in a Bill for the session of 1925.

Notes and Memoranda.

ARRANGEMENTS are being made by the city administration of Vancouver to replace the old incline railway on the side of the mountain by a power lift at an approximate cost of 125,000 dollars.

THE new Severn Tunnel ventilating plant, which has been officially started up, consists of a 28ft. fan of the "Indestructible" type and a horizontal engine fitted with drop valves and forced feed lubrication.

IN an article in the *Journal* of the Engineers' Club of Philadelphia, Mr. G. M. Basford says that continuous runs of 825 miles are now made by oil-burning locomotives and runs of over 500 miles with coal burners. Mountain type engines are operating continuously over 484 mile districts with gradients of 1.14 per cent. in one direction and 1.55 per cent. in the other direction, hauling thirteen and fourteen steel passenger cars. These engines develop 3500 indicated horse-power with a weight of 98.5 lb. per horse-power.

ACCORDING to Mr. S. Hunter, engineer for boring in the Victorian Mines Department, the brown coal seams at Bambra vary from 10ft. to nearly 80ft. in thickness, and the quality is excellent. All through the Otway ranges there are small seams of black coal, from 4in. to 8in. thick, and at Apollo Bay there are seams up to 18in. thick, but all, instead of lying flat, stand edgeways, and are unworkable. In no part of Victoria is the geological nature of the country such as to warrant the hope of finding black coal in great quantities, but the department is hopeful that it will find new deposits of brown coal which might prove extensive.

THE latest train on the Canadian National Railways to be equipped with wireless receiving sets is the International, Limited, which runs daily between Montreal and Chicago. In the observation car, in addition to the loud speaker, eight pairs of headphones are attached to the set. This style of equipment will be standardised throughout the system. The Transcontinental trains of the Canadian National Railways are now equipped with receiving sets, and all the important passenger trains will be similarly equipped as early as possible. The Canadian National Railways, in addition to utilising independent broadcasting stations, have a powerful broadcasting station of their own in Ottawa.

APPROVAL of a new type of safety device, a "self-rescuer," designed as a means of escape for persons accidentally caught in mine or other atmospheres containing carbon monoxide, has been given by the American Department of the Interior. The self-rescuer consists of a pocket size canister with mouthpiece directly attached, filled with granular fused calcium chloride and granular hoolamite—mixture of special copper oxide and manganese dioxide—which causes carbon monoxide in air to unite with the oxygen at ordinary temperatures, forming harmless carbon dioxide. Cotton filters for removing smoke are also included in the canister. The self-rescuer and a nose clip for closing the nostrils are enclosed in a hermetically sealed brass case to prevent deterioration until used. The weight complete is about 1 lb. 5 oz.

AT a recent meeting of the South African Institution of Engineers, Mr. J. A. Vaughan described an instrument he had used for detecting the presence of carbon monoxide in compressed air. The principle of the appliance depends upon the utilisation of the heat of oxidation of the carbon monoxide by means of the catalytic action of certain specially prepared granules. The heat thus produced is communicated to a bi-metallic strip, whereby it assumes a small curvature. One of the electrical contacts is carried upon another similar strip, which acts as a compensator for any changes in atmospheric temperature, so that the two contacts are always at the same distance apart, whatever the prevailing temperature of the atmosphere may be. The distance apart of the contacts is adjusted by means of a fine screw, and the circuit is completed by the bending of the bi-metallic strip which is exposed to the heat of oxidation. When this bending is sufficient the circuit is complete and an electrical bell is caused to ring.

A STUDY of temperatures in blast-furnaces using charcoal as fuel has been completed by engineers of the Department of Interior at the Minneapolis Experiment Station of the Bureau of Mines. While nearly all the iron produced in the United States is made in blast-furnaces using coke fuel, some furnaces are operated on charcoal. The charcoal iron is usually manufactured for special uses, such as in parts of motor vehicles. Temperature data regarding smelting charcoal iron were needed chiefly for comparison in the general study of blast-furnace problems. It was, according to a report which has just reached us, found that the temperatures under which charcoal furnaces are operated are lower than is permissible in coke practice. Furthermore, it was learned that the principal factor in causing this difference is the low sulphur content of charcoal compared with coke. In fact, the effect of sulphur in the blast-furnace charge is even more important than has hitherto been believed.

VANADIUM is one of the most useful of the rare metals, according to Mr. J. E. Conley. The chief deposits of vanadium, by far the most important in the world, are at Minasragra, Peru, 20 miles from Cerro de Pasco. The main ore body is a lens-shaped mass about 30ft. wide by 300ft. to 400ft. long; it contains several minerals, that constituting the larger part of the deposit being called "quisqueite." This mineral is a black carbonaceous substance containing sulphur, but no vanadium. The vanadium lies mostly at the southern end of the ore body, and to a depth of 30ft. is present as red calcium vanadate; this vanadate is brighter than that in Colorado and Utah, and it may carry as much as 50 per cent. vanadium oxide. It occurs in small pockets and fills the cracks and fissures in the fine shale. Below is the mother lode, which carries as high as 10 per cent. vanadium-oxide, and nearly as much sulphur. On the east and south sides of the mother lode is a hard blue-black vanadium shale carrying as much as 13 per cent. vanadium oxide and 4 to 5 per cent. sulphur. The main mineral is patronite, which is greenish-black and contains 19 to 24.8 per cent. vanadium oxide.

Miscellanea.

A LARGE deposit of soapstone has been found on the shores and islands of Trap Lake, Ontario.

THE new power alcohol, ether and fusel oil works at Salt End, Hull, started operations last week.

IT is proposed to build a new copper works and by-product plant on the south bank of the Tees at Middlesbrough.

THE Wolverhampton Corporation Tramways Department has decided to convert another route, that towards Bushbury, to use trolley omnibuses.

THE presidency of the Engineering Institute of Canada, made vacant by the death of Mr. W. J. Francis at Montreal, will be taken by Major George Alexander Walkem, of Vancouver, senior Vice-president.

THE Fremantle Harbour Trust is proceeding with the work of dredging the inner harbour, so as to give a depth of 30ft. at low water, and the work is sufficiently advanced to enable the largest ships trading to Australia to berth at either Victoria or North quays.

THE iron ore exports from Algeria to Great Britain during the first two months of the current year totalled 216,516 tons, as compared with 122,067 tons in the corresponding period last year. The corresponding figures for the ore exports from Tunis were 61,079 tons in 1924 and 34,713 tons in 1923.

THE Faraday Medal of the Institution of Electrical Engineers will be presented to Dr. S. Z. de Ferranti on Thursday, April 24th, at 6 p.m., on which date Mr. G. Semenza, of Milan, will deliver the fifteenth Kelvin Lecture, and will take as his subject "Kelvin and the Economics of the Generation and Distribution of Electrical Energy."

AT the annual meeting of the Manchester Steam Users' Association resolutions were adopted authorising the Committee, if it should think fit, to obtain the incorporation of the Association as a company limited by guarantee, but without the addition of the word "limited" to its name. It is stated in the report that since the foundation of the Association in 1854, "no preventable explosion has ever occurred of any boiler which has carried the Association's guarantee and certificate of safety."

AT a meeting of the members of the Manchester Chamber of Commerce, held on Monday last, Sir W. Clare Lees proposed, and the Board unanimously adopted a resolution in which it was set out that, recognising that an adequate appreciation of the post-war development of our industries could only be arrived at by the collection of a body of information such as that secured by a census of production, it welcomed the decision of his Majesty's Government to take such a census in respect of the year 1924, and affirmed its readiness to co-operate with the Board of Trade with a view to rendering the results of the inquiry as valuable as possible to industry generally.

THE Canadian Pacific Railway Company has recently despatched on a journey through the United Kingdom a special petrol-electric exhibition vehicle with the object of bringing the resources and opportunities of Canada and the transport facilities offered by the railway before the notice of the people of this country. The chassis is of the Tilling-Stevens standard 2-ton type, on which is mounted a special body van, the sides of which are hinged so that they can be folded back to display examples of Canadian produce, &c. A portable kinematograph displaying apparatus forms part of the equipment, while provision has been made for the electric lighting of the displays when exhibited at night.

THE Board of Trade has certified that certain statutory regulations which have been approved by the Japanese Government relating to overloading, so far as regards the assignment of load lines to Japanese ships, are equally effective with the corresponding regulations in force in this country respecting the assignment of load lines to British merchant ships. An Order in Council, dated March 21st, has therefore been made, directing that on proof that Japanese ships have complied with the aforesaid Japanese regulations, such ships shall not, when in ports of the United Kingdom, be liable to detention for non-compliance with the provisions of the Merchant Shipping Acts relating to overloading, nor shall there arise any liability to any fine or penalty which would otherwise arise for non-compliance with those provisions.

THE report presented to the Faraday Society on Monday concerning the great explosion which took place at Oppau, in Germany, in 1921, does not throw much light on the cause of the disaster. The report, which was compiled by the Government laboratory at Woolwich, was introduced by Sir Richard Threlfall, who said that the investigation of the double salt, ammonium sulpho-nitrate, that exploded, showed that it was impossible to detonate the material even under the most powerful compression and by the use of the most powerful initiators. It was impossible to come to any definite conclusion as to the cause of the explosion, but among the least unlikely was the existence in the store, through oversight or accident, of pockets of unmixed nitrate. The general conclusion was that the double salt is quite safe, in reasonable quantities, for use as a fertiliser.

A CO-OPERATIVE agreement has been arranged between the British Columbia Bureau of Mines and the United States Department of the Interior, whereby the North-West Experiment Station at Seattle will assist the first-named organisation in establishing the best conditions for converting steel scrap, tin-plate scrap, and spongey iron concentrates into foundry iron and steel, through the medium of the electric furnace. This work is a continuation of the laboratory work on synthetic iron previously done at Seattle by the Bureau of Mines. It is expected that the results will be applicable to the production of grey iron from spongey iron. The tests will include observations on the relation of charge to product, methods of controlling the composition of the product, power consumption, costs, &c. The furnace is of the Greene (Heroult type) three-phase, acid-lined and of 3000 lb. capacity.

LOCOMOTIVE BOILER REPAIR WORKS AT BISCHEIM

(*For description see page 405*)

TUBES ROLLING FROM ONE MACHINE TO ANOTHER

RIVETING THE STAY BOLTS

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THE ENGINEER.

APRIL 18, 1924.

The Control of Locomotive Running.

"Should the Traffic Department control locomotive running?" is the question which Mr. H. A. Watson sought to answer when reading his interesting paper, entitled "Organisation of Traffic and Locomotive Departments in Relation to Running," before the Institute of Transport on the 7th inst. It is a question that has been before us for years past, and we still think after reading Mr. Watson's carefully reasoned arguments on the subject, that the last word has not yet been said upon it.

Up to comparatively recent times, the Locomotive Superintendent was, without question, considered to be the officer responsible for the construction, maintenance and operation of the locomotives. It was he who supplied the power, complete with men, to the Traffic Department. Under such a system, and acting under the Locomotive Superintendent, an assistant—a locomotive engineer specialising in locomotive running—was provided, who, on the larger lines at any rate, became known as the Running Superintendent, and was supported in turn by Divisional Superintendents, who had control of certain sections. That organisation has advantages which, so far as we can see, outweigh any of the shortcomings with which it is credited, and the reasons advanced for relieving the Locomotive Superintendent or Chief Mechanical Engineer, as we now know him, from any work so far as the running of the engines is concerned, leave us cold. Granted that the Chief Mechanical Engineers have in all the mechanical appliances now employed other than the locomotives themselves, largely increased responsibilities, we are not disposed to regard that as a convincing argument for divorcing the work of construction from that of operating locomotives. The locomotive engineer in practice is assisted by other officers, each one of whom is responsible to the Chief for the various types of plant, hydraulic, electric, and others which come under the Department, and quite reasonably so. Why not a Running Superintendent as well? Mr. Watson holds that such an official adds another department under the General Manager. But he need not do so if he continues to report to the Chief Locomotive Engineer, who, in turn, reports to the management. In supporting the handing over of the control of the enginemen and others, even to the Locomotive Inspectors, except the running shed fitters to the Operating Department, it is admitted that difficulties are to be encountered, one of which is the status of the engine shed foreman. In order to get over this trouble, dual control is rightly discredited, and it is suggested that the shed foreman should not only maintain the engines, but manage the running as well, acting for the former under the Mechanical Engineer and for the latter under the Operating Superintendent. In other words, the running shed foreman, or whoever may be in charge, is to hold an appointment which is, in effect, almost exactly similar to that of the Chief Locomotive Engineer who controls the enginemen, thus re-creating in a small way the very same state of affairs which the advocated system seeks to terminate. We do not for a moment pretend to say that the running of the locomotives by the operating officers cannot be satisfactorily accomplished, but we can plainly see that the position in the Running Shed is fraught with dangers, and the foreman in charge would be in a difficult position. The Operating Department is interested in the engine only when at the head of its train; the Mechanical Engineer is at all times interested, and his anxiety is not only concerned with the proper handling of the engine by its crew, but also with its proper repair, and its condition when passing from the engine terminal into traffic. The efficient handling of locomotives is in itself a most important matter; in fact, too great a point cannot be made of it, and the passing of enginemen for their duties, and the subsequent supervision of their work can hardly be in safer hands than those of the Chief Mechanical Engineer. It is an engineer's work to see that mechanical appliances, be they locomotives or others, are properly handled. We do not think the fact that drivers when on the road are, in the main, working to the instructions of the Traffic Department, affects in any decided manner the arguments we have advanced in support of the old system.

We have considerable regard for the points made by Mr. Watson with reference to the status of signalmen, crane drivers and others who operate apparatus maintained by departments other than those to which they themselves belong, but at the risk of being accused of seeing a distinction that is without a difference between those cases and that of the locomotive and its *personnel*, we express the opinion that whilst the new system may have advantages, they are more than counterbalanced by the advantages of the old. In the management of locomotives the various aspects of design, construction, maintenance and handling, are so bound up each one with the other, that a system which keeps the control of all functions under one head, must in the end give better results than a method of control which may add certain additional difficulties to an already complex problem.

Base Metal Supplies.

Attention has recently been called by responsible authorities to the fact that our supplies of base metals—*i.e.*, of the non-precious non-ferrous metals—are very far from unlimited, and that, in fact, even at the current rate of consumption we may look for the approaching exhaustion of some of them, among which lead and copper are specially mentioned, in rather less than a hundred years. We have, of course, grown accustomed to predictions of this kind in regard to the world's coal supplies, and still industries entirely dependent upon heat and power derived from coal remain unchecked. That we are, in this respect, more or less squandering the heritage of coming generations does not seem to trouble us, and no doubt the non-ferrous industries will suffer no hindrance from the warning in question. Nevertheless, we would suggest that such a matter demands serious consideration. In the first place, fuller inquiry as to the soundness of the data upon which such an estimate is based seems desirable, but if we find them to have a really substantial basis of fact and to be built up on sound reasoning, a series of further problems arises. It may perhaps be said that what is likely to happen a hundred years or more hence need not trouble our industries very seriously at a moment when they are struggling against more immediate difficulties. In a limited sense and from a somewhat narrow point of view, that may be true enough, but there is a more pressing consideration. If we are, really, so near the limit of the world's resources in these metals that virtual exhaustion will occur within a century, we must be very much nearer the point where the increasing scarcity of these materials will begin to bring about an important increase in price, and that is a condition which may well be expected to exert an influence on the non-ferrous metal industries, even in our own time.

If that untoward event occurs, what is the way out? The question has two different aspects,

which require separate consideration. In one sense this is a world-wide problem, one which, apart from special conditions, is likely to affect the whole of the world's industry in a similar manner; that is to say, the rise in price of non-ferrous metals will be felt throughout the civilised globe. Its effect on engineering industry and technology, however, is likely to be profound—how profound our recent war-time experiences of the effects of shortages of certain metals will suggest. The problem would thus seem to call for a co-ordinated world-wide effort at solution, and since such problems are often long in the solving, it is eminently desirable in the interests of the progress of engineering that the effort should not be long delayed. There is, however, a narrower national aspect of the case. Incipient shortage of these metals will certainly not make itself felt at the same time and to the same extent in the various countries of the world. Where the resources have been long and heavily drawn upon, exhaustion is likely to arise the sooner. A stage will be reached, and it may persist over a considerable period of years, in which the remaining accessible supplies of some metals will be concentrated in one country or a small group of countries which will thus derive great industrial advantage from the situation. It may be that such advantage will accrue to some part of the British Empire, but obviously not to Great Britain, so that, sooner or later, we may well have to face the darker side of this picture. From this point of view, the matter assumes definite national significance for ourselves, and the finding of a satisfactory solution of the problem becomes a question of very real national importance, and one which, although the contingency itself may seem remote, yet demands immediate and serious attention. Those natural advantages which we enjoy through our adjacent supplies of coal and iron have enormously diminished in our time, partly by the increasing exhaustion of our own resources and by the development of greater natural resources in other countries. We can scarcely hope to restore those glories by the discovery of new and unsuspected deposits in our own islands. But the fact is that under modern conditions of international commerce and world-wide transport, the exact location of natural resources is of much less importance than it was a century ago. What really matters is the knowledge that will enable us to utilise resources hitherto unsuspected or regarded as of little value, wherever they may be situated.

In this prospective depletion of the supplies of non-ferrous ores, there would seem to be reason and need for research. Since it is a world-wide problem, it is likely to receive attention in many countries, and the future advantage will lie largely with that nation which discovers how to overcome the shortage of non-ferrous metals and which has the enterprise to carry that discovery into full practical application. It is therefore of the first importance that in a race of this kind we should, if possible, take the lead, or at the least that we should not be left behind. Nor need we fear competition in such a question, since in metallurgical research we have established our position in the very front rank of the nations—by some, indeed, we are freely acknowledged as leaders. Perhaps the indefiniteness of the problem may at first sight appear forbidding, but it is less indefinite than it appears, since several plain aspects at once present themselves. With a prospect of shortage of copper, zinc, lead and tin, we have yet aluminium and silicon, to say nothing of lesser-known but relatively plentiful elements, such as zirconium. Aluminium and silicon are already finding widening uses, but the problem of production—particularly of aluminium—on a huge scale and at low prices is by no means solved. As long as we are restricted to bauxite and similar materials as a source of aluminium, this problem remains unsolved. We wonder how great an amount of effort is at present being devoted to this particular question? It is true that much work has been done and many failures recorded in past attempts to extract aluminium from its silicates, but we cannot afford to be daunted by this record of difficulties, and, as we have pointed out, it may at any time become a matter of great national importance. Then there is the problem of the production and exploitation of the other fairly plentiful materials, which at present are only slightly used, if at all; while, on the other hand, the question arises whether a fuller knowledge of iron and its alloys may not make it possible to utilise ferrous materials where now non-ferrous are preferred. Here, again, there is need for investigation along lines which so far have scarcely been considered. These are large problems, many of them only hopeful of solution if attacked on something like a national scale. Is it too much to hope that a truly long view may be taken in the hope that our future industrial position may be assured upon a basis of discovery—not, this time, of material treasures, but of treasures of knowledge which should truly, in such a case, prove to be power?

Institution of Mechanical Engineers.

AIR CONSUMPTION AND BRAKE HORSE-POWER OF INTERNAL COMBUSTION ENGINES.

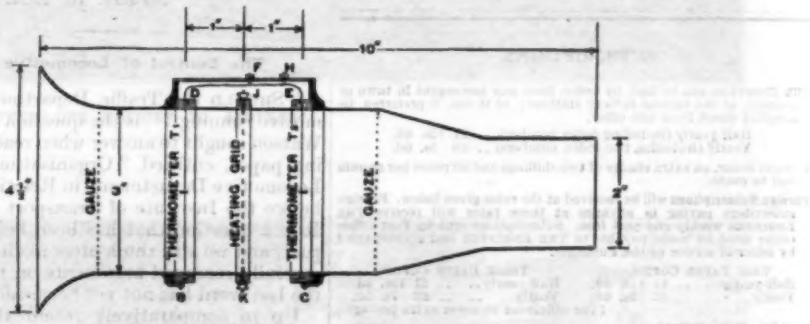
Last Friday evening, at a meeting of the Institution of Mechanical Engineers held in London, Dr. H. Moss, of the Air Ministry Laboratory, presented a paper entitled "The Relationship of Air Consumption to Brake Horse-power in Internal Combustion Engines; Road and Flight Tests."

The air consumption of an internal combustion engine is an item of interest by itself and also by virtue of its being a possible means of determining the brake horse-power of a motor car engine on the road or of an aero engine in flight. The relationship between the air consumed and the brake horse-power is governed by a complexity of factors, but Dr. Moss has found that under full power conditions and with air petrol ratios lying between 11 and 14, the indicated and brake horse-powers are very nearly proportional to the air consumption. It therefore follows that a simple means of measuring the air consumption of an aero engine or a motor car engine would provide valuable assistance in the investigation of the outputs under actual running conditions.

The method of measuring the air consumption adopted by Dr. Moss was originated by Professor H. L. Callendar, and has been used by several others. It consists simply of measuring the amount of electrical energy which is required to heat a stream of fluid through a given interval of temperature. In our issue of August 4th, 1922, a description will be found of a practical application of the same principle in an article describing the Thomas gas meter.

The theory of the method is not difficult to follow. If a resistance of R ohms with a potential difference of V volts across its terminals be inserted in a steady current of air flowing at the rate of W grams per second, the energy developed as heat in the resistance will be V^2/R joules per second, and the energy added to the air will be $J S W t$ in joules per second where J is the mechanical equivalent of heat, S the specific heat of the air, and t the range through which its temperature is raised by the heat received from the resistance. These two quantities being equal we have $W = V^2/R S J t$. If S be taken as the specific heat *at constant pressure* and as being substantially constant at all temperatures and pressures likely to be met with, J S becomes a constant, and on the metric system is numerically equal to 4.18×0.24, or very approximately unity. The equation thus simplifies to $W = V^2/R t$. If the material of the resistance has no temperature coefficient R is constant, and if t, the temperature rise, is chosen at some given value, say, 1.5 deg. Cent., then the equation becomes $W \propto V^2$, that is to say, the air flow is proportional to the square of the voltage which must be applied to the resistance to raise the flow 1.5 deg. Cent. in temperature.

The instrument used by Dr. Moss is indicated in the accompanying engraving. On each side of a heating grid J K is a resistance thermometer B D, C E. By means of a connecting wire the two thermometers are used as two arms, F D B and F E C, of a Wheatstone bridge, the point F being found experimentally and being such that with no current in the heating grid there is no deflection of the galvanometer needle. In this condition there is a small heating effect derived from the current flowing in the thermometers, and this fact prevents the point F being fixed otherwise than experimentally. In use the terminal F is discarded in favour of the terminal H, the resistance F H being chosen such that no deflection of the needle will occur when the second thermometer is 1.5 deg. Cent. higher in temperature than the first. The measurement of the voltage applied to the heating grid to produce such zero deflection is effected by means, detailed in the original, which are designed to eliminate the effects of vibration and of temperature changes in the parts of the measuring device.



ELECTRICAL METER FOR MEASURING AIR FLOW

Full details of the calibration and preliminary testing of the system are to be found in the original paper. The flow meter, as the measuring device is appropriately called, was calibrated in a steady stream of air, the flow of which was independently measured by means of an air box provided with a circular sharp-edged orifice. It was found that the two measurements agreed to within one part in 200. The air box and flow meter were then transferred to the inside of a Ford van in order to examine whether the meter behaved equally well when the air flow was not steady but was the actual flow to an engine. It was found that the air box and flow meter readings differed by some 5 per cent. This discrepancy arose from the formation of vibrations in the air in the connecting tubes, and could be eliminated by damping out these vibrations by inserting a small silencer between the flow meter and the engine.

The flow meter was next applied to a single-cylinder 40 horse-power Benz aero engine. With an air reservoir of 1½ cubic feet capacity between the meter and the carburetter it was found that errors arising from the variable velocity of the air flow were eliminated, and that the meter gave the correct mean value of the flow. A larger size of flow meter was then constructed and applied to a six-cylinder Siddeley "Puma" engine—nominal output 240 brake horse-power at 1400 revolutions per minute. The flow meter was calibrated as before in a steady stream against an air box and was subsequently applied to the "Puma" engine run on the bench. In the latter test the readings were checked against simultaneous air-box readings, and it was found that the steady stream calibration applied to the engine trials with an error which did not exceed 1 per cent. On the bench test it was found that at full or slight throttle the brake horse-power lay between 1.08 and 1.07 per gram of air per second. When the engine was severely throttled down, however, the value fell to 1.04.

In some preliminary flight tests it was found that the conditions for the operation of the device were considerably steadier than on the Ford van, and that the presence of the flow meter reduced the engine speed by only 10 revolutions per minute and the air speed by but 1 per cent.

From a variety of tests made during flight at various altitudes up to 14,000ft., it was deduced that the indicated horse-power of an aero engine is very nearly proportional to the density of the air at the flying level and that the air consumption, as measured by the flow meter, should give the brake horse-power with a possible error of less than 2 per cent. It is particularly noted that when an aero engine is throttled down to half power on the ground the conditions are not quite the same as those experienced when the power falls to one-half as a result of altitude conditions, and that further experiments are required to establish a more exact relationship between brake horse-power and air consumption.

Mr. J. L. Hodgson opened the discussion, and pointed out that one of the great merits of the air meter used by the author was the fact that its readings were not affected by pulsations in the air column, so long as they were of moderate extent. If the pulsations did not carry the heated air back to the first thermometer again, the readings would be unaffected. In contradistinction to this, the orifice method of measuring air necessitated the complete damping out of any vibrations in the flow. Another advantage of the electrical meter was the fact that it gave directly the weight of air passing, although any water vapour in the air would affect the readings. On the other hand, with an orifice meter, it was necessary to take account of the temperature and pressure of the air in order to obtain the mass. The chief disadvantage of the electrical meter was, he said, the cost of the current used by the heating element, which might be as much as £1 a day when metering 700,000 cubic feet of gas per hour. This disadvantage did not,

however, apply to Dr. Moss's instrument, the current consumption of which was trifling. Mr. Hodgson described a receiver with flexible diaphragms, which he had used for damping out the pulsations of the air flow in testing a motor car engine by the orifice method.

Colonel T. H. Tizard recommended the Venturi tube as an air meter for aeronautical work, on account of its simplicity. He had, he said, tried it on the choke tubes of aero engines and secured consistent results, while the pulsations in the air flow did not seem to be of very great importance. He admitted the accuracy of Dr. Moss's method, but criticised it on the grounds of complexity. The inaccuracies of the Venturi tube method ought, he held, to be explored by means of the flow meter.

Mr. A. E. L. Chorlton asked whether the instrument had to be calibrated at the ground level for each engine and each engine setting, or whether one calibration was sufficient for all engines at all settings. He also asked whether the instrument had been tried on the exhaust side of the engine.

Mr. W. Reavell was surprised that the author had used a sharp-edged orifice for calibrating his instrument, and asked the author what coefficient and what formula he had adopted. Mr. Reavell preferred a parabolic orifice, as it was much more simple to make the calculations required, and had a coefficient of almost unity, viz., 0.99. The electrical system of metering air would, he thought, be very good, if it could be shown to inspectors that it was reliable, but account would have to be taken of the moisture content in the air.

Mr. L. A. Legros commented on the general principles adopted by the author, in view of the fact that aero-engines were always run at practically full load, whereas a motor car engine had to operate over a very wide range. He suggested that experiments should be carried out on the relationship between torque and air consumption at high speeds. A knowledge of this air consumption would be of special help to carburetter makers.

Captain H. Riall Sankey expressed curiosity as to the method adopted by the author for converting indicated into brake horse-power. The deduction from the indicated horse-power of a constant figure for the frictional and other losses as determined by motoring the engine round would lead to an absurdity at no load.

Mr. W. H. Patchell said that the Thomas electrical meter had been used in Detroit in 1914 for measuring the air supply to boilers. The results were practically the same as those obtained with a nozzle.

In his reply, Dr. Moss said that normal amounts of water vapour in the air did not materially affect the meter readings, but the device could not, of course, be used if the machine were run into a cloud. He had not tried the instrument on the exhaust, as the specific heat of the exhaust gases was so variable.

At the close of the meeting Lieut.-Colonel Kitson Clark exhibited a model he had borrowed from the Leeds Museum, which was believed to be Smeaton's own model for the foundations of Eddystone Lighthouse. It was made of wood, and indicated plainly the form of each of the stones used, besides the means adopted for keying them to the sloping face of the rock.

Literature.

Modern English Architecture. By CHARLES MARRIOTT. London: Chapman and Hall. Price 21s. net.

THIS is a book on architecture for the general public. With no more knowledge of architectural terms than may be gleaned from a desk dictionary, the reader may follow Mr. Marriott's arguments without any fear that he may have missed the meaning through uncertainty about technicalities. In his first few chapters the author deals with general principles, and in the remainder with modern architects and with specific examples of modern styles. But whether he is discussing architecture in gross or in detail, Mr. Marriott reveals a robust philosophy of the art of building which is occasionally a little startling and always invigorating. He insists over and over again upon influence of "craft," as opposed to "art," on building, and is convinced that Gothic architecture, or at least Gothic ornament, resulted rather from the material and tools employed than from the volition of the workpeople. Indeed, he holds that nowadays we make too much conscious effort, that there is too much striving after effect, and that we should be better architects if we let the materials and the tools exert more control over design. A longish quotation from his chapter on ecclesiastical architecture will give an idea of Mr. Marriott's philosophy. "The truth seems to be that in artistic matters you cannot successfully make aims of what were originally consequences. The Gothic craftsmen were ordinary workmen, who became artists by the quality of their work; Sedding and his collaborators in Holy Trinity were highly cultivated artists who became workmen 'by conviction.' Things are not done that way. It is extremely unlikely that the carvers, painters, glaziers and metal workers of the Middle Ages had any more conscious convictions about craftsmanship than has the modern plumber. The probability is that, like him, they grumbled most of the time and slacked whenever they got the chance. What they had was precisely what he has: that dumb conscience for the job, resembling the loyalty of the sailor to the sea, which comes not by artistic conviction, but the sheer, and generally resented, discipline of tools and materials." But whilst our author holds this view as to the craft of building, he is convinced that the architect must be moved by high and definite motives. He feels, for example, that the increasing vagueness about religion bodes badly for the ecclesiastical architecture of the future. "It is safe to say," he remarks, "that a building which aims at expressing an ideal, however lofty and universal, without reference to some definite form of belief will express nothing." We can imagine that an architect who was called upon to erect a building for the accommodation of the Third International might find it a little difficult to attain that precision of thought and intention which is demanded for the attainment of a high ideal.

When we pass from ecclesiastical to commercial architecture, having in the interval skipped over several interesting chapters, Mr. Marriott brightens existence for us by his comments on the relationship between architecture and shopkeeping. "Paradoxical as it may sound," he writes, "the commonest defect in shops is not that they are too commercial, but that they are not commercial enough. Most of the shops in our larger cities give the impression of being too big for their boots; not so much in mere size, but architecturally; of bolstering up what they really perform with the architectural associations of what they claim, in a word, they are pretentious." —a remark which recalls Joe Gargery's criticism, "Which I mean ter say as it is there drawed too architectooralooral." "Very few modern tradesmen," continues Mr. Marriott, "would be content with a plain architectural statement of shopkeeping, however convenient it might be from a practical point of view and good in proportion. The whole convention of modern shopkeeping demands the combination of catchpenny expedients with the assumption that the shopkeeper is a Pillar of Society." As far as the great women's shopping centres are concerned that assertion is, we believe, perfectly true. The shop fronts are advertisements; they take the place of the drum, which is the "ducadme" of the cheapjack; but in the City there is more restraint—is it because men are the chief customers?—and many of the shops show a simple fitness for their purpose which is in pleasant contrast with the pretentiousness condemned by our author.

Over Mr. Marriott's final chapter we should linger, but that it might be an impertinence for engineers to express opinions on the artistic and spiritual side of architecture. Our author, however, comes into the field where architecture and engineering join hands when he approaches the question of the influence of material upon building form. "Change of substance," he says, "demands a change in the proportions in order to produce the same emotional effect. Whether we like it or not, we feel the actions involved, the 'convenience of the workman' in producing the form. . . . Substance, in fact, is the link between design and purpose, and no application of design to purpose can leave substance out of account." That seems to us to be a very sound observation, despite the fact that it has been consistently disregarded by architects from the days of the Greeks, who imitated wooden beams in stone, to the present day, when we imitate stone beams in concrete. What is needed for the elevation of architecture in concrete is a frank admission of the material. It is to be regretted perhaps that it started under a false name. Had cement never been called "Portland," because it resembled Portland stone, had it been so hopelessly unlike stone that pretence was impossible, it would ere this have found itself. Mr. Marriott is far too sensible in his views upon architecture not to foresee that steel and concrete are "substances" which may lend themselves to artistic treatment, and he has even a good word for machine productions used in their proper places. Let us close our survey of a book which all who take an interest in living architecture will read with a few sentences which bear upon this matter. "Prophecy is rash, but one improvement which may be looked for in architecture is the franker use of machine construction and machine production. We have still to find how girders 'go' in architectural design and the true form of reinforced concrete; and until we do it is inevitable that there should be a gap between the engineering and the architectural treatment of large buildings. There is nothing to be ashamed of in machinery as long as you do not let it master you. Its franker use and expression is all the more desirable since the prevailing style in our large buildings is classic rather than Gothic." We commend the remainder of the passage to the attention of architects and engineers. Just as it is beginning to be realised that to get the best out of mechanical piano players music must be expressly written for them, so must we admit that to use steel and concrete to their best artistic advantage buildings must be expressly designed to satisfy the characteristics of those "substances." The French have gone further in that direction than we have, and they are producing in armoured concrete architectural effects which are proper to that form of construction and to that form alone, and which not for an instant leave the spectator in any doubt as to the "substance" employed. They are showing, too, that a real grandeur is as readily attainable with armoured concrete as with stone if the proportions proper to that material are combined with the fundamental principles of the grouping of masses.

The Modern Soap and Detergent Industry. By GEOFFREY MARTIN, D.Sc., Ph.D. Vol. I. Crosby Lockwood and Son. Price 36s.

DR. MARTIN is an industrious and versatile writer on technical chemistry, and in the present work, which is to run to three volumes, he deals with an important industry more fully than preceding authors. A feature of the book is the frequent reference to recent publications and to the patent files, which should render it of special utility to the technical chemist or engineer. Although many soap works are large concerns—one at least will recur to everyone at once as of imposing magnitude—the trade can be carried on, and successfully too, on the backyard scale. It follows, then, that the details of the processes are of close interest to many men far outside the Peerage, and though the general process of the saponification of fats is discussed in innumerable works, the volume under notice certainly cannot be considered superfluous if only on the score of fullness of treatment and of modernity.

The subject matter is divided into seven sections:—I., Nature of Soap and Detergent Action; II., Organic Raw Materials Used in the Soap Industry; III., Inorganic Materials Used in the Soap Industry; IV., Perfuming Substances; V., Manufacture of Soap from Free Fatty Acids; VI., Boiling Process for the Manufacture of Soap; VII., Household and Laundry Soaps. In the last section we find some disquieting references to cheap materials used in laundry soaps, but it is something for the public to know that soaps of any sort are used in these days of laundry detergents, of which we shall probably hear something in the second volume. In the description of the manufacture of caustic soda from soda ash it is stated that the lime mud after washing is dumped or dried and sold to farmers for liming land. This somewhat scanty information might well have been elaborated as some progress, at any rate, has been made of late in turning it to better effect than selling it—more often giving it—to farmers. One other point with regard to alkali; in referring to the manufacture of soda crystals in British and American works, the author gives one to understand that the addition to the soda ash solution of calcined Glauber's salt in order to facilitate the production of large and colourless crystals is the universal method employed, and the only analysis of soda crystals given shows 2.5 per cent. of sodium sulphate. This method, no doubt, is largely used, and it is legal to sell soda crystals with up to 2.5 per cent. of sulphate, but we may say that a large amount of crystal soda is made without the aid of Glauber's salt, and only a trace of sulphate is to be found in the finished product.

The section of the book devoted to perfumes indicates the extent to which such bodies now find application in the soap trade. The reference, by the way, to the discovery of so many cheap synthetic perfumes makes us wonder whether any of the recent factories we once inspected at Grasse have gone out of business. The book is well illustrated and got up, and should command a wide circle of readers interested in the varied aspects of soap technology. As a final word, in the interests of accuracy, may we say that, as there are no fellows of the Society of Chemical Industry or Society of Analysts, the letterpress of the author's list of qualifications on the title page needs some revision.

BOOKS RECEIVED.

Foundry Work. By W. Roland Needham. London: Blackie and Son, Limited, 50, Old Bailey, E.C. 4. Price 2s. 6d. net.

Low Temperature Carbonisation. By C. H. Lauder and R. F. McKay. London: Ernest Benn, Limited, 8, Bouverie-street, E.C. 4. Price 35s. net.

The Supervision and Maintenance of Steam-raising Plant. By Charles A. Suckan. London: Ernest Benn, Limited, 8, Bouverie-street, E.C. 4. Price 30s. net.

The Journal of the Institute of Metals. Volume XXX. Edited by G. Shaw Scott. London: Published by the Institute, 36–38, Victoria-street, S.W. 1. Price 31s. 6d. net.

Alignment Charts for Engineers and Students. By W. J. Kearton and G. Wood. London: Charles Griffin and Co., Limited, 12, Exeter-street, Strand, W.C. 2. Price 16s. net.

The Workmen's Compensation Acts, 1906 to 1923, with Notes, Rules, Orders and Regulations. By W. Addington Willis. London: Butterworth and Co., Bell-yard, Temple Bar, W.C. 2. Price 15s. net.

First General Report of the Lignite Utilisation Board of Canada. Covering operations from October 1st, 1923, to January 1st, 1924.—Canada: Published by the Board, 288, St. James-street, Montreal.

Electrical Measuring Instruments: Their Design, Construction and Application. Part I., Commercial and Indicating Instruments. By C. V. Drysdale and A. C. Jolley. London: Ernest Benn, Limited, 8, Bouverie-street, E.C. 4. Price 55s. net.

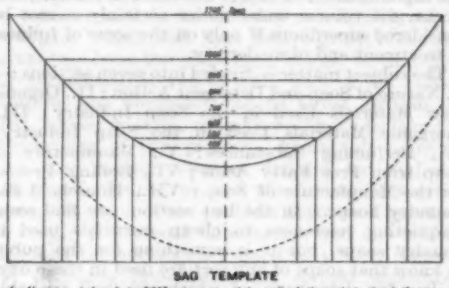
High-tension Transmission Lines.

By ERNEST V. PANNELL.

No. VI. (*conclusion*).*

SECTION IV. CONSTRUCTIONAL ELEMENTS.

Survey.—In the preliminary survey for a high-tension line, the factors influencing the route are quite different from those in the case of a railway. Gradients and hilly country are usually sought in the case of the transmission line, because with the high tensile strength conductors now in use, every effort is made to construct with the maximum practicable tower spacing and to achieve this object the supports must be placed on hilltops as far as is practicable. A transmission line in the Southern States recently put into operation at 150 kilovolts is representative of this practice, for whilst the average span on the level portion of the route is 800ft., that in the mountain sections is nearly 1500ft. Generally, too, the rougher the nature of the country, the cheaper will be the wayleaves; in fact, a strip of territory can probably be acquired outright in the mountains, but that would be economically impossible in cultivated regions. In



SAG TEMPLATE

for Aluminium-steel conductor 0·327 sq. ins. area erected according to the constants given in the paper. Vertical scale = 10 x horizontal scale. Minimum ground clearance 25'. All spans up to 1500'.

"THE ENGINEER" SWAIN Sc.

FIG. 25

surveying alternative routes, a careful balancing of the different right of way charges will frequently determine the actual path to be followed. The surveyor will not avoid long valley or ravine crossings, but will minimise all avoidable crossings of railways, highways and navigable streams, because all of them call for more expensive construction. On the other hand, it is of the greatest value to run the line parallel with a railway or highway; such a route is well worth a higher cost and an extended mileage.

Spotting.—As a result of the preliminary survey, the office engineers are provided with maps and profiles of the route to be followed by the line, which provide the basis for its mechanical design. Judgment will decide the relative use of single or double circuit towers, after which it is necessary to fix the position of, or "spot," the towers on the map and the profile. The latter will probably have a vertical scale ten times the horizontal scale; in this case a sag template—Fig. 25—is made to the same scale to represent the curve followed by the wire when strung on any span. If this curve is drawn or cut on transparent celluloid, and a parallel curve drawn beneath it, separated by the amount of the ground clearance, the template so formed can be laid upon the profile, and at a glance the most suitable positions for supports can be seen at the same time as their height. In this work, it will be remembered that adjacent spans should be as nearly as possible equal. If a great disparity exists, it will be necessary to interpose an anchor tower. The reason will be understood by an inspection of the stringing curves—Fig. 26. At minimum temperature, when the wire is shortest and the difference in tension at its maximum, the difference in weight between spans of 600ft. and 700ft. is 6000 lb., without ice loading. Between two such spans as 1200ft. and 1300ft., however, the difference is less than 80 lb. This fact illustrates one manner in which long-span construction is simplified. However, the variation between adjacent spans must not be very great, and in any given section of the line between dead end points, the spans must all conform as closely as possible to the average length. By making them do so, the suspension insulators will hang as nearly as possible vertical at all temperatures. Where the difference in tension is slight, a semi-anchor tower or weights can be introduced. It is best to use weights wherever possible, because they do not in any way destroy the flexible character of the suspension insulator line. It is not necessary to add sufficient weight to counterbalance the swing entirely, but only to restrain it to a reasonable angle. A mechanical axiom of the suspension insulator line is that "loads originating with the conductors should, as far as possible, be absorbed by the conductors." Weights will permit a transient swing of the insulator chains throughout a long section of line during a squall, sleet storm or other disturbance. On the other hand, the interposition of dead ends will cause all loads to be transmitted direct to the strain insulators and to the towers. In "spotting" towers, it will sometimes be found necessary to have a support at the foot of a hill. Wherever possible, that course should be avoided, but the uplift force in the conductors must be calculated, and suitable weights suspended to neutralise that stress.

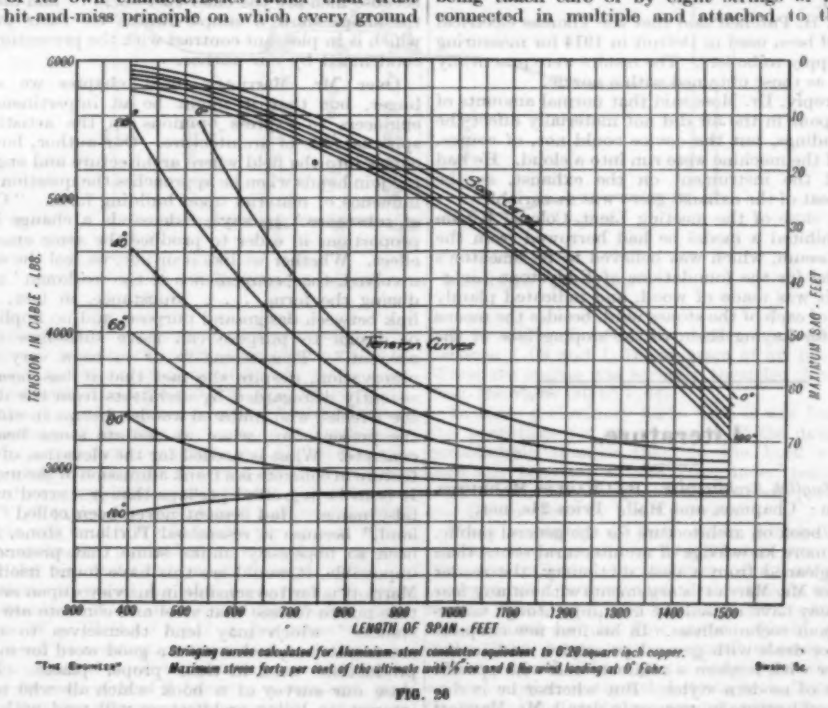
Changes in Alignment.—At the point where the line had to turn an angle, it was once customary to install a dead end tower. That practice put considerable strain at one point in the line, and such a point was always particularly liable to trouble from lightning and other causes. It is now usual to dispense with the dead end, and to use standard towers spaced more closely than usual, so that the line may be turned a few degrees at each. The average suspension tower is designed to carry the tension due to a side angle of 5 deg., and if the span be shortened up this angle can be increased so that a 45 deg. turn can be made with four or five standard towers. In such a position, the use of weights is a particular advantage, especially on one side of the tower, because the side pull of the angle will draw the wires towards the structure, so that there is risk of grounding in a high wind. Weights of 50 lb. to 100 lb. are used on one system for such small angles, but other lines are using up to 800 lb. for each weight.

As already mentioned, the swing of the insulators in the direction of the line, while it should be restrained within safe limits, is necessary for the absorption of temporary mechanical loads. But the swing of the insulator in the transverse direction is less desirable, and the insulators are therefore sometimes suspended from links which are free to swing longitudinally, but not transversely. Thus, they virtually add their length to the pendulum when oscillating in the direction of the line, but do not cause any deviation from the vertical at a horizontal angle. A further feature of the use of links is that their use reduces the load arising from a broken wire.

Ground Wires.—A wire, usually of steel, run over the topmost conductor and grounded at every pole or tower, has become a recognised feature of line construction. Its utility in an electrical sense consists in interposing a plane of ground potential between the source of atmospheric disturbances, and the line, so that most direct lightning strokes and a number of induced disturbances are without doubt drained off by the ground wire. However, the tendency of design is to produce a line which is electrically so substantial that it can absorb or damp such disturbances by virtue of its own characteristics rather than trust to the hit-and-miss principle on which every ground wire operates. It is sometimes said that construction with a steel ground wire can be lighter because of the extra longitudinal stability which it produces. As a matter of fact, the exact contrary is the case. If a tower is to be designed for the failure of one wire, it is the ground wire that will be selected, because from its position the failure of it will occasion greater forces in the structure than the breakage of any one of the conductors. For this reason, the tower must be heavier where a ground wire is strung. Further, not only is the ground wire strung in a situation most difficult of access for maintenance purposes, but it is usually of a material the life of which is far shorter than that of the conductors. Failure of this steel wire is therefore not only more probable than that of the conductors, but, when it occurs, is far more disastrous, as the broken strands may ground and burn off all the wires of one or both circuits.

Where the ground wire is of distinct mechanical value is on an A frame or semi-flexible line. In that case, the construction is designed to withstand little or no longitudinal load, so that every additional wire which is strung provides an additional factor of safety by minimising the effect of the breakage of one individual wire. In such a case, the ground wire ought to be of the same material as the conductors, but that practice is seldom or never followed. Galvanised steel seven-strand cable of .375in. to .500in. diameter is generally used, and although the wire is extra galvanised, its life cannot be more than seven years in a moist climate. Copper-clad wire is sometimes used, and is much better than galvanised steel. In general, however, it seems to have been the policy of transmission engineers to exercise economy in respect of the ground wire, and that being so it would often be far better to eliminate it altogether.

Extra Long Spans.—In several instances transmission wires are carried across a river or valley from 3000ft. to 5000ft. wide. The construction of such long spans necessitates special study. It will generally be found necessary to string the wires with a very high degree of tension, because the sag increases as the square of the span length and the supports therefore become abnormally high. As at present installed some of the towers supporting conductors across navigable waterways are as high as 350ft. even where high tensile steel cables are used. One of the most remarkable of these long spans is to be found on the Pacific Coast, where the 165-kilovolt lines of the Great Western Power Company cross the mouth of the Sacramento River, which there goes by the name of the Straits of Carquinez. The distance between supports is 4753ft., the clearance above high water 206ft., and the height of the towers 195ft. The especial importance of maintaining clearance above a navigable waterway is realised when it is mentioned that a power line span in the vicinity of this one was recently grounded by the steel mast of a cargo vessel passing below. In Fig. 2 *ante* is shown the section of the cable used on the Great Western's span, from which it will be seen that it is virtually of steel with a layer of aluminium for electrical purposes. The anchor clamps are affixed to the steel core, and although the aluminium of necessity takes up some of the load by friction, the area of the steel only is used in the mechanical calculations. It will be remembered that an aluminium steel cable having 50 per cent. steel will carry 80 per cent. of its load on the core. In the present combination the proportion of steel is over 60 per cent. There are two circuits strung on the towers, and the tension per wire varies up to 20,000 lb., being taken care of by eight strings of insulators connected in multiple and attached to the tower



Stringing curves calculated for Aluminium-steel conductor equivalent to 0·20 square inch copper. Maximum stress forty per cent. of the ultimate with ½" ice and 8 lbs wind loading at 0° Fahr.

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FIG. 26

by means of coiled steel springs which assist in damping mechanical vibrations.

Another long crossing of the same strait is made by the lines of the Pacific Gas and Electric Company, and although the pressure is only 60 kilovolts, the work is more remarkable in a sense being a pioneer construction; it has been in operation more than twenty years. The length of the crossing is 4427ft., but an advantage exists over the situation of the Great Western line in that the Pacific Gas line is run between two moderately high bluffs which help to reduce the tower heights for the same clearance. In this instance the cables are carried over the pin type insulators on the main towers by rollers and anchored to strain towers, some distance in the rear, at both ends. This arrangement is customary where it can be employed, because it relieves the high crossing towers of dead end strains, transferring them to a shorter structure. The chief disadvantage lies in the necessity for a very long and a very short span in contiguity, which, with changes in temperature, causes considerable longitudinal movement of the conductor that must be taken up by some arrangement. In such a position suspension

* No. V. appeared April 11th.

insulators are impracticable, and it is generally necessary to build up pedestal insulators so as to support a runway over which runs a saddle to which the conductor is attached. This device generally need be introduced only at one end of the span. In several of the earlier installations the conductors were anchored at one end, and at the other they were run over sheaves and attached to counterweights. In this way the stress in the wire was kept constant at all times, but the sag varied. Mechanically it cannot be said that this counterweight device offered any particular advantage.

As shown in an earlier part of these articles the chief problem to be faced in long-span construction is that connected with the low factor of reliability of strain insulators. A notable installation which solves this problem is the crossing of the St. Lawrence River by the 110-kilovolt lines of the Shawinigan Water and Power Company near Three Rivers, Quebec. The distance spanned is 4801ft. between supports and no strain insulators are used. The crossing is made by three high-tensile standard steel cables of 1⅛in. diameter running over sheaves at each of the main 350ft. towers and anchored to strain towers behind them. These steel cables are, of course, grounded to the tower framework. From these steel wires the copper conductors are hung by suspension insulators spaced 250ft. apart. The stresses coming upon both the conductors and the insulators are, therefore, those relating to 250ft. spacing, and all the heavy loads are carried by the steel. The matter of insulator maintenance on a span of this kind is a difficult one, however, and because of their inaccessibility insulators must be selected with a very liberal factor of safety against flashover as well as against puncture.

The erection of a cable across a navigable waterway is usually a problem in rapid construction, because the obstruction of the channel for any length of time cannot be tolerated. Furthermore the matter is complicated where there is a strong tidal flow, because if the tide is running when the wire is run out from the barge or tugboat it will inevitably drag a long way downstream. The wire must, therefore, be run out during slack water, and as soon as the shore is reached it is hitched to a pilot line which is carried around the drum of a steam winch and the cable is hoisted up to tension. The final straining up is effected by inserting a triple sheave and tackle or a still further reduction if necessary. If the channel is frozen solid in winter that is by far the best time for erection, and the problem is then very much simplified. When stringing across a very deep channel it may be necessary to buoy the conductor when running to prevent damage to it.

Economics.—A study of the cost of transmission line construction would require a very thorough treatise, so many and variable are the factors involved. It is not possible in these articles to do more than indicate in the most superficial way the order of the main cost items, and such figures as are quoted here relate to actual heavy line construction which has been accomplished, but which furnishes no exact criterion upon which the cost of other lines may be estimated.

About £3000 sterling per mile of double circuit is a representative figure for the type of construction with which these articles deal. Figures for material can be estimated with exactitude, labour is a little less certain, while the cost of wayleaves may vary between almost any limits. Contingencies and changes in line construction do not appear to be very significant factors where the design has been carefully worked out, and special construction for railway and river crossings is usually a matter of just so much extra steel, insulators and labour. Using the above figure of £3000 sterling per mile, and applying it to the 150-mile 80,000-kilowatt line under survey, the cost will be found to be between £5 and £6 per kilowatt capacity, not including transformers. Now the capital cost of an economically satisfactory hydro-electric development is of the order of £30 sterling per kilowatt capacity. From this, it is interesting to note that the development of transmission line engineering has been such that the capital charges per kilowatt-hour 150 miles from the power source are only about 18 per cent. higher than at the plant itself.

The significant items of the total line construction cost, under reasonably normal conditions, may be set out as follows:—

(A) Right of way		7 per cent.
(B) Material—		
1. Towers	20	
2. Insulators	8	
3. Conductors	40	
4. Hardware	3	
		—71 per cent.
(C) Labour—		
1. Clearing	2.7	
2. Hauling	1.3	
3. Excavations	2.3	
4. Setting footings	3.5	
5. Assembling towers	3.8	
6. Stringing wire	2.0	
7. Cleaning up	1.4	
		—17 per cent.
(D) Administration—		
1. Survey	0.5	
2. Engineering	0.8	
3. Legal	0.2	
4. Interest	0.5	
5. General expense	3.0	
		— 5 per cent.

The above proportions relate to the estimated overall figure already quoted of £3000 sterling per mile of double-circuit line, and it will be observed that over 70 per cent. of the total is represented by costs of material which can be exactly calculated. Considerable variation is therefore permissible in the items of labour and administration, without a very serious effect on the total cost. The cost of right of way is in every way the most uncertain, varying from a purely nominal sum per tower for the right of access, to a figure of £1500 sterling per acre of land for freehold purchase. Generally on a long system, this item will tend to average down, because a great part of the country covered will be sparsely settled uncultivated land.

Conclusions.—The aim of these articles is to present a few of the most interesting features of transmission line design, especially as followed at the present-day in America. It is feared that the subject is far too wide to be treated with justice in articles of this character, but they may at least serve as an outline of the subject. As far as the possibilities of extended power distribution in Great Britain are concerned, there is virtually nothing in the modern American power line which is not applicable to British conditions. A potential of 150 kilovolts is by no means confined in its utility to systems extending over 150 miles, and the main reason for the rapid increase in operating voltage is not distance at all, but capacity. Some of the power systems operating at 130 kilovolts in Pennsylvania and Ohio are much smaller in extent than would be the case of a unified network for the English Midlands. As was just seen, the conductors for a 150-kilovolt transmission system represent 40 per cent. of the total construction cost. How much greater will this item become if an appreciably lower voltage is used?

The case for reliability of the overhead line no longer needs defence. Cities of approximately one million population are satisfactorily supplied with light, power and traction by means of transmission lines between 100 and 200 miles in length, and the interruptions to service are negligible. Shut-downs, such as do occur, are due to two primary causes—(*a*) lightning and (*b*) severe sleet storms. Neither of these conditions has much significance in Great Britain. Furthermore, a transmission system to-day is a complicated network of power stations and sub-stations and different undertakings are interconnected across many hundred miles of country, so that practically any power station or section of line can go out of operation without affecting the supply for more than a matter of seconds. The transmission line, the product of the civil, mechanical, structural and electrical branches of the art, represents engineering of the highest type, and its performance is no longer subject to uncertainty, but is proved no less dependable than any other engineering development.

New Refuse Salvage Works at Birmingham.

The Birmingham City Council some time ago decided that the tipping of crude refuse should cease entirely, both inside and outside the city boundaries, and that, instead, the waste matters should be treated in a series of salvage works. As a commencement of the new order of things, a very complete salvage works has been erected in Brookvale-road, and it was officially opened by the Lord Mayor of Birmingham—Alderman T. O. Williams—on the 9th inst. It is anticipated that three somewhat similar works will have to be erected, so that the refuse from the whole area under the Council's control may be effectively dealt with. The Brookvale-road works, of which a plan is given in the engraving on the next page, will serve an area of 6830 acres, comprising the following wards:—Erdington North, Erdington South, Aston, Handsworth (part), and Lozells (part). The area, which contains over 30,000 houses with a population of approximately 150,000 persons, may be compared, in size, with such towns as Birkenhead, Oldham, Southampton, Swansea and Sunderland, and the estimated tonnage of refuse produced in it and to be treated in the new works is 36,000 tons per annum. The collection of refuse will be performed by means of thirteen 5-ton electric vehicles, which will displace 31 horses and a number of carts at present used for this work. The drivers of these vehicles have been selected from among the existing horse drivers.

Before definitely deciding to build on the present site, the Salvage Committee made exhaustive searches in the Witton area, with a view to finding the best site for the works, and it was unanimously agreed that Brookvale-road had greater claims than any others which were offered or considered. There was this difficulty in connection with the site, however, that there was a depth of 7ft. or 8ft. of peat to be dealt with before the good hard sand and marl of the district was reached, but it was overcome by the use of reinforced concrete piles. One great advantage of the site is that the canal runs alongside, and it was, therefore, convenient to put in a special canal arm to deal with the clinker, &c., intended to be boated away. A further advantage was that the average level of the ground was approximately 9ft. lower than the canal, and it was also possible to enter the site from Brookvale-road canal bridge, which allowed of the inclined roadway being of an easier gradient than would otherwise have been available, and also made it a simple matter to arrange for an electric vehicle garage under the inclined roadway. Further, the site is situated in a nearly central position of the district that the depôt will eventually serve.

The scheme was brought before the Ministry of Health on May 24th, 1922, and sanction for the loan was obtained. There was no opposition to the scheme, and any comments made were entirely in its favour. Tenders were invited for the whole of the work before the inquiry, and immediately on receipt of the Ministry's sanction, the work was proceeded with. The specification was prepared by the Salvage Department after a thorough investigation of the various methods of refuse disposal, but those tendering were left to put forward schemes to meet the conditions outlined therein.

The scheme proposed by Heenan and Froude, Limited, for the main contract, including salvage plant, destructor and buildings, was adjudged to be the best submitted to meet the requirements set out in the specification, and was ultimately approved and accepted.

The general scheme called for:—

(*a*) A weighbridge and office at Brookvale-road entrance to weigh refuse on its entry to the depôt, and another weighbridge and office at Moor-lane entrance for weighing all outgoing materials;

(*b*) An approach road in reinforced concrete, to be so constructed as to give garage accommodation for 18 electric vehicles;

(*c*) Three refuse hoppers, each of 10 tons capacity, and with feeding device to screens;

(*d*) Three screening and conveying units and means whereby these 3 units could serve an additional destructor unit if required at a future date;

(*e*) A picking belt to each screen for the purpose of taking off saleable articles and carrying the remainder of the refuse to the refuse storage hoppers;

(*f*) A refuse storage hopper with a capacity of 100 tons;

(*g*) Provision for refuse to be taken in the collection vehicles direct to the storage hopper in case of breakdown in the refuse screening plant;

(*h*) Two units of 4 cells of the top feed type, capable of burning to a hard innocuous clinker 80 to 100 tons of house refuse per day;

(*i*) Clinker crushing, grading and sorting plant, for dealing with the residue from the furnaces, and means for discharging the unscreened clinker into barges, in the canal arm, and the graded clinker into vehicles;

(*j*) Magnetic separators for removing iron from the crude refuse and also from the crushed clinker;

(*k*) A canal arm for the accommodation of boats to be loaded with the screened dust and clinker, &c., and means provided for the conveyance of the dust direct from the screens to the barges;

(*l*) An alternative method for disposing of screened dust into road vehicles;

(*m*) A steam-driven generating plant, electric vehicle charging equipment, and lighting of the depôt, the power to be derived from the burning of house refuse;

(*n*) In addition to the above sections detailed in paragraphs (*a*) to (*m*), the specification required provision to be made for a canteen, a workshop, lavatories, electric generators and hydraulic presses.

The main contract for the plant and buildings, excluding the ferro-concrete work, was placed with Heenan and Froude Limited, Worcester and Manchester, and portions of the main contract were sub-let by them with the approval of the Salvage Committee.

Tenders for the reinforced concrete, designed on the Hennebique system, including foundations to the canal arm, canal arm proper, a tow-path bridge for the canal arm, the piling and foundations to the destructor buildings, the inclined roadway and electric vehicle garage under it, were obtained, and that of Wilson Lovatt and Sons, Limited, Wolverhampton, was accepted; Mouchel and Partners, Limited, being the designers and consulting engineers for the ferro-concrete work.

In August, 1922, Wilson Lovatt and Sons, Limited, commenced the erection of their temporary stores and offices, and the casting of the reinforced concrete piles for use on the works. Altogether on the job, 218 12 × 12 piles were made and driven for the destructor and canal arm, and 60 14 × 14 piles for the inclined roadway and garage. The piles were cast in summer weather, and at the end of four weeks three days, the first pile was driven on September 14th, 1922. The maximum number of piles driven in any one day was 15. The last pile was driven on November 7th, 1922. As several extra piles were required for the foundations of the hydraulic accumulator for the tin bundling plant, it was necessary to make and drive these additional piles very quickly, and to overcome this difficulty a special cement was used. These special piles were driven by the ordinary pile driver, three days after being cast. No cracks were observed, and some time after, when one of the piles was bared

in excavating to some other work, no difference was found between it and an ordinary concrete pile which was bared at the same time. The average number of blows used in driving each pile was 300, the drop being 2ft. 6in.—with the exception of the piles made from the special cement, which received a 3ft. drop—and the set for the last 10 blows was less than ¼in. Some difficulty was experienced in driving the piles in two or three cases, as a large number of tree roots was found in the peat.

Description of the Plant.

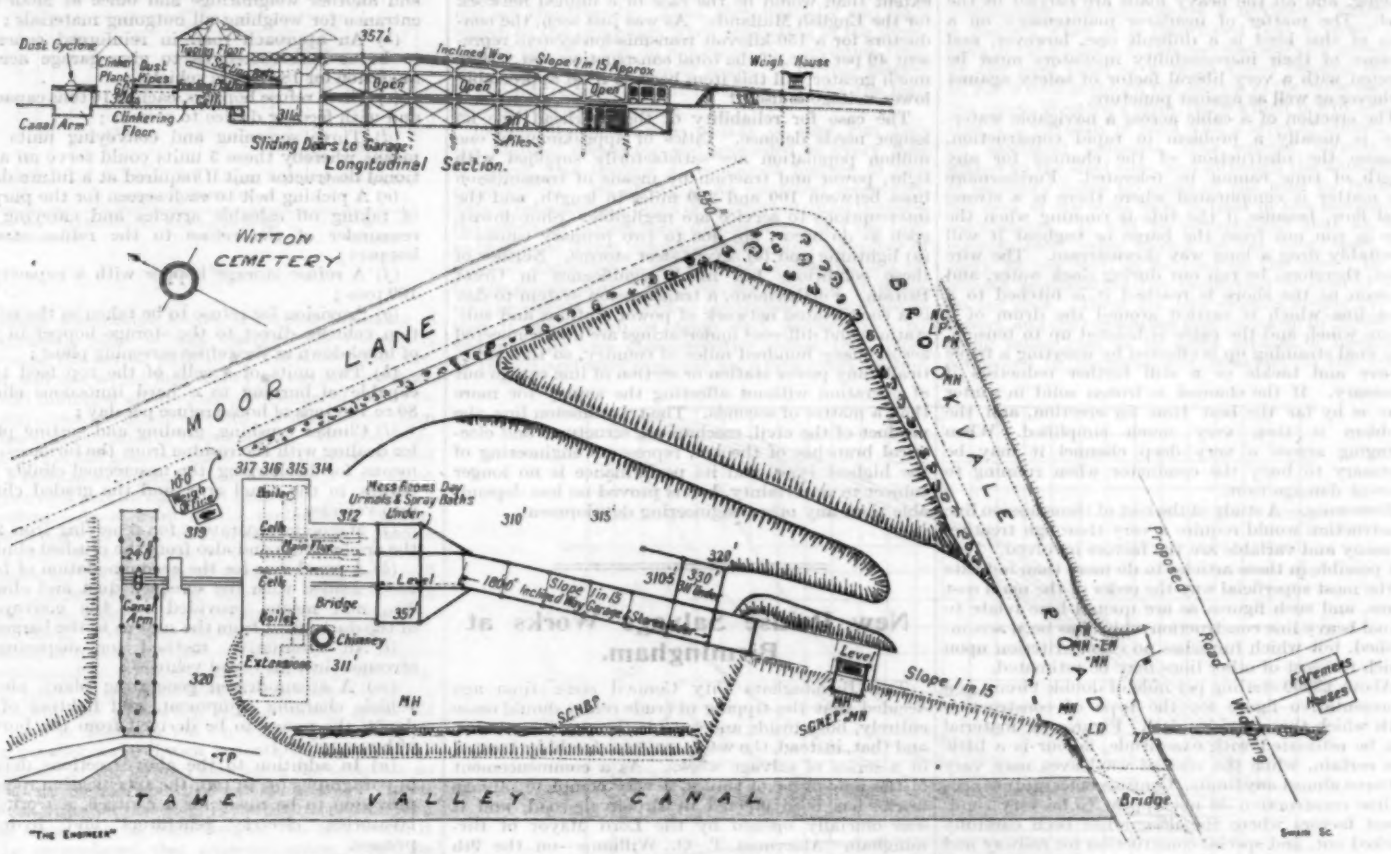
The refuse on arrival at the works is weighed over a 20-ton Avery machine situated on the inclined roadway about 80ft. from the entrance. The second weighbridge, which has been installed for weighing material leaving the depôt, also has a capacity of 20 tons, and each has a 18ft. by 8ft. platform. The slope of the inclined roadway is 1 in 15, and is quite reasonable for either horses or motor vehicles. For the first 100ft. the inclined roadway was formed by tipping destructor clinker, produced at other destructor depôts of the Salvage Department. The remaining portion of the roadway is composed of reinforced concrete and forms the garage for the electric vehicles to be used for refuse collection at this depôt. At the end of the inclined roadway is a large tipping platform, and the material, in the ordinary course of events, will be tipped at this point into three large steel hoppers, each capable of holding about 10 tons of refuse and each fitted with a feeding device to enable them to be emptied with a regular flow into the circular screens. The automatic feeders are arranged to deliver the refuse at the rate of 10 tons per hour to the screens, which are designed to take out the whole of the fine dust, which is estimated at approximately 40 per cent. of the whole. It is proposed to boat this dust direct to the Great Barr tip—the dust having no objectionable qualities—or to sell it for manurial purposes. Hoppers are arranged underneath the screens in order to collect the dust. Each of the hoppers is provided with a two-way outlet chute, one branch of which delivers the dust to a reciprocating feeding plate, which enables a uniform flow to be maintained, while the other branch delivers the dust directly into tractors or other vehicles.

The screens are completely enclosed to prevent the dissemination of light dust into the building. The screened dust from the refuse is transported from the storage hoppers and is loaded direct into the canal barges by means of a new and improved method of conveyance by air pressure, which Newton Collins, Limited, designed and manufactured in collaboration with Heenan and Froude, Limited. Three centrifugal motor-driven blowing fans, of 15 brake horse-power each, deliver the air under low-pressure into the conveying pipe lines and thence to the feed injectors, where the dust, falling by gravity from the reciprocating plates, is induced into the pipe lines. An air velocity of approximately 50 miles per hour is maintained throughout the conveying pipes. The air pipe lines lead from the feed injectors along the underside of the screen house floor, turning through 90 deg. under the high-level road bridge, and thence through the destructor building to cyclone separators, which are arranged over the canal basin, the separated dust falling by gravity into barges. The conveying system is divided into three independent units, the three conveyors being designed to deal with 20 tons of screened dust per hour. The upkeep and maintenance cost of this conveying system are expected to be low, as none of the conveyed dust passes through the fans.

The refuse as it passes through the screen is cleared of all magnetic material by means of a magnetic separator, of a type suggested by the Salvage Department, and developed by Heenan and Froude, Limited, in collaboration with the Rapid Magnetting Machine Company, Limited, of Birmingham. These separators have the twofold object of:—(1) Recovering the tins and depositing them alongside the belts where they can be taken to the ground floor and pressed in a bundling plant; and (2) increasing the value of the clinker, which will be free from the objectionable iron contents. At the delivery end of the screen a cylindrical brass piece is fixed to the deadplate, and forms an extension to the barrel, this extension piece revolving inside a fixed electro-magnet, which is of half moon shape. The iron, tins, nails, &c., which are carried forward with the refuse are attracted against the inside of the brass plate and are carried round and upward to a point where, by means of adjustable throw-off fingers, they are brought to the end of the magnetic field influence and dropped into the shoot delivering to the side of the belt. The "tailings," after they leave the screens, fall on to conveyors of the band type, horizontal sections being provided for the "picking" operations. The "tailings" are then carried forward on an inclined conveyor belt and are delivered into the storage hopper above the cells, which has a capacity in the neighbourhood of 100 tons, and is adjacent to, and on the same level as, the feeding openings to the destructor furnaces.

Each screening unit, comprising the feeding gear, screen and conveyor, is self-contained and is driven by a separate motor. A specially designed suction plant has been installed to collect the waste paper from the end of the conveying belts, and to deliver it, dust free, to baling presses. An exhaust fan, directly coupled to a 15 brake horse-power Crompton motor, is fixed above the picking belts, and the main suction pipe is carried by and supported from the girders forming the tipping floor. The suction pipe is divided into three 16in. diameter branches, each of which communicates with a mouthpiece fitted with adjusting mechanism to bring the opening in close proximity to the discharge end of the conveying belts. The suction set up in the mouthpieces induces a stream of air which can be regulated to pick up loose paper, and necessarily with it, other light matter as it passes over the belts towards the furnaces. This mixture of paper and light dust is then drawn through the piping system and discharged into a special grading separator, fixed on the roof over the picking ends of the belts. The function of this separator is to release the air from the solids and to divide the latter into two independent chutes, one of which delivers the paper—dust free—on to the baling press feeding floor, while the other conveys the loose dust to a point where it can be filled into sacks, or returned directly to the centre conveying belt. Great care has been taken in the design and construction of the plant to provide against the risk of choking the pipes; all bends are of easy radius and there are no internal projecting screws, so that the pipe lines offer a smooth bore which ensures an easy and uninterrupted passage for the waste paper. The design, manufacture, and installation of this waste paper collecting and cleaning plant was carried out by Newton Collins, Limited, Birmingham.

There are two openings in the floor of the room in which the waste paper recovery and cleaning plant is installed, under which are placed two movable baling boxes to receive the papers. When the cages are loaded, they are run on a prepared track to a paper baling press, supplied by Hollings and Guest, Limited, of Birmingham. In the specification of the plant it was laid down that the capacity of the bale before compression should be approximately 50 cubic feet, and that, after compression, the bulk should be reduced to about 15 cubic feet. The press is arranged to facilitate the wiring of the bales before the pressure is removed. In the event of any mechanical breakdown in the screening and conveying plant, provision is made for the carrying forward of the crude refuse over a high-level bridge to a tipping floor, directly over the charging floor. As a further safeguard, in the event of a breakdown, the crude refuse can be placed directly into boats and boated direct to the tips.



PLAN AND SECTION OF THE REFUSE SALVAGE WORKS, BROOKVALE ROAD, BIRMINGHAM

purposes. A feature of the plant is that all the flues are above the ground, and are thus rendered easily accessible for cleaning and repairs, exceptionally large cleaning doors being provided for this purpose.

The chimney, which was built on the "Custodis" principle, is 134ft. high from the concrete base, and has an internal diameter at the top of 7ft. It is firebrick lined throughout its length, and internal steel bands have been introduced to prevent cracking.

Twenty-five piles were driven as a foundation for the chimney and the capping of the piles forming the concrete base for the chimney is independent of the raft on which the building is carried. Forced draught is provided by motor-driven fans placed at the rear of the furnaces. The whole of the piping, including the main steam, auxiliary steam, feed mains, with the full complement of valves, steam traps, &c., was included in the main contract, together with two Weir feed pumps, having a capacity of 2000 gallons of water per hour, when running at 14 double strokes per minute, with and against a working pressure of 160 lb. per square inch. The feed water is drawn from the hot well, put down in conjunction with the generating sets.

Clinker Plant.

A mono-rail overhead railway, with skips equipped with raising and lowering gear, provides the means of transporting the clinker to the cooling area or to the clinker plant. The runways are slung from lattice braced girders which span the yard from the main building to the clinker plant, so that supports in the yard, which are altogether undesirable on account of their interference with the traffic, have been entirely avoided. The clinker crusher, which for ease in feeding is placed below ground level, is driven by a separate motor. This crusher has easily adjustable jaws so that it can be made to crush the clinker to any desired size. The crushed material is elevated by means of a bucket elevator to the top of the clinker hoppers. There, any magnetic material, such as nails, &c., which may have been embedded in some combustible material in the refuse and not taken out by the magnetic separators on the refuse screens, is removed by means of a magnetic separator of the drum type, manufactured by the Rapid Magnetting Machine Company, which consists of a half-moon shape electro-magnet mounted on a stationary shaft, about which revolves a brass cylinder. Parallel with the axis of the drum, and fitted across the whole width of it, is a number of brass angle throw-off slats. The hubs of the non-magnetic end covers are fitted with Skefko dust-proof ball bearings. About one of the hubs is fitted a sleeve suitable for mounting any ordinary type of pulley drive, and the stationary shaft upon which is mounted the half-moon magnet unit above described is fitted to supporting members by means of ordinary adjustable type fixed brackets. The position of the magnet is variable to the best position relative to feeding facilities, and the drum is operated by means of a double pole, quick-shunt break switch and fuse panel. The necessary non-inductive resistance double-pole fuses, and double-pole quick break knife pattern switch, are all totally enclosed in a cast iron case, having a hinged glazed front.

The mixed material, consisting of clinker and iron, after leaving the elevator, is fed on to the top of the drum, which is revolved at a suitable speed to convey the material into a main and diverting chute. The non-magnetic material passing over the drum drops vertically from the horizontal outer position of the drum into the main chute, while the magnetic material is carried round to the back bottom position and there released into the separate diverting chute provided for receiving it. After the crushed clinker has passed over the magnetic separator, it is fed into a rotary screen approximately 4ft. diameter by 18ft. long, the screen meshes being of varied gauges, so that the clinker can be graded and stored into their respective hoppers. The hoppers are arranged with discharge doors so as to deliver to the side of the building, and the space underneath the hoppers is reserved for mortar mills. The elevator, magnetic separator and screens, are driven by a separate motor arranged near the screen. All the electric motors were manufactured by Crompton and Co., Limited. They are of the pipe ventilated, shunt-wound, inter-pole type, and run at 650 revolutions per minute. The complete wiring from the distribution boxes in the power-house to the various motors, together with the motors and starters, was included in Messrs. Heenan and Froude's contract, and consists of V.I.R. cables throughout, with the exception of the wiring across the yard to the clinker plant, which is C.T.S. cable. All the starters are of the slow-motion type. They are fitted with no-volt releases and are rated for eight 30 second starts per hour.

The bundling presses are hydraulically operated in the ordinary way, the hydraulic pressure being provided by motor-driven pumps. The electric generating plant comprises two high-speed condensing engines, each coupled direct to a 100-kilowatt continuous-current compound-wound generator, made by the Electric Construction Company, Limited, of Wolverhampton. The engines are of Belliss and Morcom's two-crank compound type. They run at a speed of 525 revolutions per minute, and develop a normal continuous output of 145 brake horse-power, with a steam pressure of 100 lb. per square inch, when exhausting into a "Belliss" surface condenser, which is common to the two engines. The condensing plant pumps are driven by an auxiliary engine of the same design as the main engines, and is thus independent of the electric current supply. The air pump, which is of the "Edward's" type, is driven through enclosed gearing from one end of the auxiliary engine, the centrifugal circulating pump being direct-coupled at the other end. The condenser has a cooling surface of 510 square feet, and is designed to maintain 26in. vacuum with both engines running into it, and to be capable of dealing with 8400 lb. of exhaust steam per hour. The current produced by the plant will be used for power purposes, depôt lighting, and for charging the electric vehicles. The steam for driving the engines is obtained from the heat produced by the burning of the refuse, no other fuel being used. The 220 volt supply for lighting purposes is obtained from the 440 volt supply by means of a three-wire balancer set. A five-wire balancer set has been installed for charging the batteries to the electric vehicles. Eighteen battery charging panels are installed, and each panel is fitted with instruments, switchgear and a regulating resistance, which are mounted on an enamelled slate carried on an angle iron frame. The generating plant, balancer sets, and charging equipment have been installed by the United Electrical Company (Birmingham) Limited, while the electric lighting has been carried out by Mr. S. Dodd, Harborne, Birmingham. The whole building is wired with C.T.S. cable made by Callenders Cables, Limited, and is equipped with fittings of Ediswan Limited's manufacture.

SIXTY YEARS AGO.

In our issue of April 15th, 1864, a curious assortment of subjects was presented to our readers' attention. We reprinted a Royal Institution address by W. S. Savory, dealing with dreaming and somnambulism, and devoted nearly three columns to a Society of Arts paper by Professor Morgan, describing a new process of preserving meat. Elsewhere we had an article describing the manufacture of sugar and designed to show "the soundness of the principle of the graduated scale of duties adopted by Mr. Gladstone." There was, however, one article in the issue which was, or should have been, of intense interest to engineers. It was an article, a mere column in length, entitled "The Strength of Iron." In it a brief and somewhat confused account was given of the experiments carried out by Mr. (Sir William) Fairbairn on the effect of repeated loading on structures such as bridges. These experiments provided the first sight of what we now call fatigue in metals, anticipating in that respect the publication of Wöhler's results by six years or more. Fairbairn quite clearly showed that failure would occur after a limited number of applications of the load if the load were two-fifths or more of the ultimate breaking load. He could detect no sign of approaching failure after a million applications of two-sevenths of the ultimate load. He does not appear to have conceived the idea involved in what we call the fatigue limit. On the other hand, he clearly stated that wrought iron girders subjected to repeated loading producing a stress of 7 tons per square inch were not safe, but would incur a risk of fracture after 300,000 or 400,000 repetitions, while at 5 tons they would sustain over three million applications without showing signs of failure. That we at least failed to grasp the full significance of Fairbairn's results—it would not be difficult to find an excuse for such failure—is evident from a note appended to the article in which we stated, apparently by way of full explanation of the subject, that "in full size structures a wide margin has to be left for possible unsoundness of material and imperfect workmanship not likely to occur in a model." . . . Elsewhere in the same issue we gave particulars of the experimental equipment to be used by an American Government Commission, consisting of Messrs. Horatio Allen and B. F. Isherwood, which had been appointed fully and fairly to test the value of working steam expansively. The equipment consisted of a single-cylinder vertical engine capable of taking a cylinder 12in., 14in., 26in. or 30in. in diameter by 24in. in stroke. The load on the engine was supplied by a series of ten fans all of exactly the same size and form mounted on a common shaft. On the full-stroke non-expansive trial the size of the fans was to be adjusted until when running at 200 revolutions they provided the resistance for the full power working of the cylinder. With the cylinder changed for expansive working additional fans would be applied to the shaft to measure the increase if any in the power developed.

BOOKS OF REFERENCE.

List of Collieries on or Connected with the Great Western Railway Company. Paddington Station, Great Western Railway, Superintendent of the Line's Office, W. 2.—This book contains a list of the collieries which are adjacent to stations on the Great Western Railway system in South Wales and Monmouthshire, North Wales, the Forest of Dean, Shropshire, South Staffordshire, Somersetshire, &c., with details of the invoicing stations for each pit and particulars as to the class of coal produced. In two excellent maps there are shown the relative position of each coalfield to the railway company's system as a whole and the position of coal invoicing stations in the Monmouthshire and South Wales area. Particulars are also given of collieries where washing plants, are installed, and a list of patent fuel manufacturers and foundry coke producers on the system is included. The facilities afforded by the Great Western Railway Company at its ports for shipments of coal is clearly defined, and other useful information, valuable to persons interested in the coal trade and to large consumers of fuel, is embodied in the book, which may be obtained on application to the Superintendent of the Line, Paddington.

The Directory of Shipowners, Shipbuilders and Marine Engineers. 1924. The Directory Publishing Company, Limited, 33, Tothill-street, S.W. 1. Price 20s. net.—We welcome the twenty-second edition of this handy volume, which is issued somewhat earlier than usual, but nevertheless appears to include most of the recent changes in the *personnel* of shipping companies, and the change of departmental officials brought about by the advent of the Labour Government. In spite of additions which have been made the volume has been kept small in size, and is convenient for travelling use. The first section gives information concerning the Admiralty, the Board of Trade, and the Ministry of Transport; also the various British and Foreign Classification Societies. Next follows the Shipowners' Section of 450 pages, after which some 110 pages are devoted to Shipbuilders and Repairers and Marine Engineers. Directories of Consulting Marine Engineers and Naval Architects, also the Trade and Technical Institutions, are given. A valuable part of the book will be found in the carefully prepared indexes of the various parts of the volume, which include a personal index and an index giving the name of the ship and a reference to its owner.

The Empire Municipal Directory and Year-book, 1924–25, which is published by *Municipal Engineering and the Sanitary Record* (the Sanitary Publishing Company, Limited), of 8, Breams-buildings, London, E.C. 4, price 10s. 6d. net, is in its forty-second year of publication.—The present volume, which has just reached us, appears to be in no wise less encyclopædic than those which have gone before it. It contains a mass of information of special interest to municipal officials of all denominations. The book is divided into sixteen sections, of which the first—running to 188 pages, or half the total—is a comprehensive directory of local authorities and their officials at home and in the overseas Dominions, an addition, given in this year's volume for the first time, being a selection of some of the leading foreign cities with their principal officials. Section II. is devoted to "Road Construction and Maintenance"; Section III. to "Plain and Reinforced Concrete"; and Section IV. to "Lighting, Heating and Ventilation." "Municipalities and Motors" form the subject of Section V., and "Water Supply, Purification and Softening," and "Sewerage and Sewage Disposal" of Sections VI. and VII. respectively. Then follow sections on "Health Officials and Sanitation," "Municipal and Public Health Law," "Public Cleansing and Waste Utilisation," "Fire Prevention," Housing and Town Planning," "Labour-aiding Plant and Appliances," "Public Recreation Grounds," and "Municipal Engineering, Public Health and Scientific Societies." Finally there are a buyer's guide and a three-day to the page diary commencing on Tuesday, April 1st, 1924, and terminating on April 22nd, 1925, so as just to overlap the official year of Local Authorities which terminates on March 31st.

The Universal Directory of Railway Officials, 1923. London: The Directory Publishing Company, Limited, 33, Tothill-street, Westminster, S.W. 1.—As a direct result of grouping, this Directory has shrunk to half its former size. Nevertheless, its compilers have quickly mastered a very difficult job, and whilst we have a smaller Directory, it in no way lacks the value of its predecessors. With the next issue we hope to see many of the blanks filled under the grouping. Our regret is that many great names, household names, in fact, are missing from this volume. The price of this volume is 20s. net.

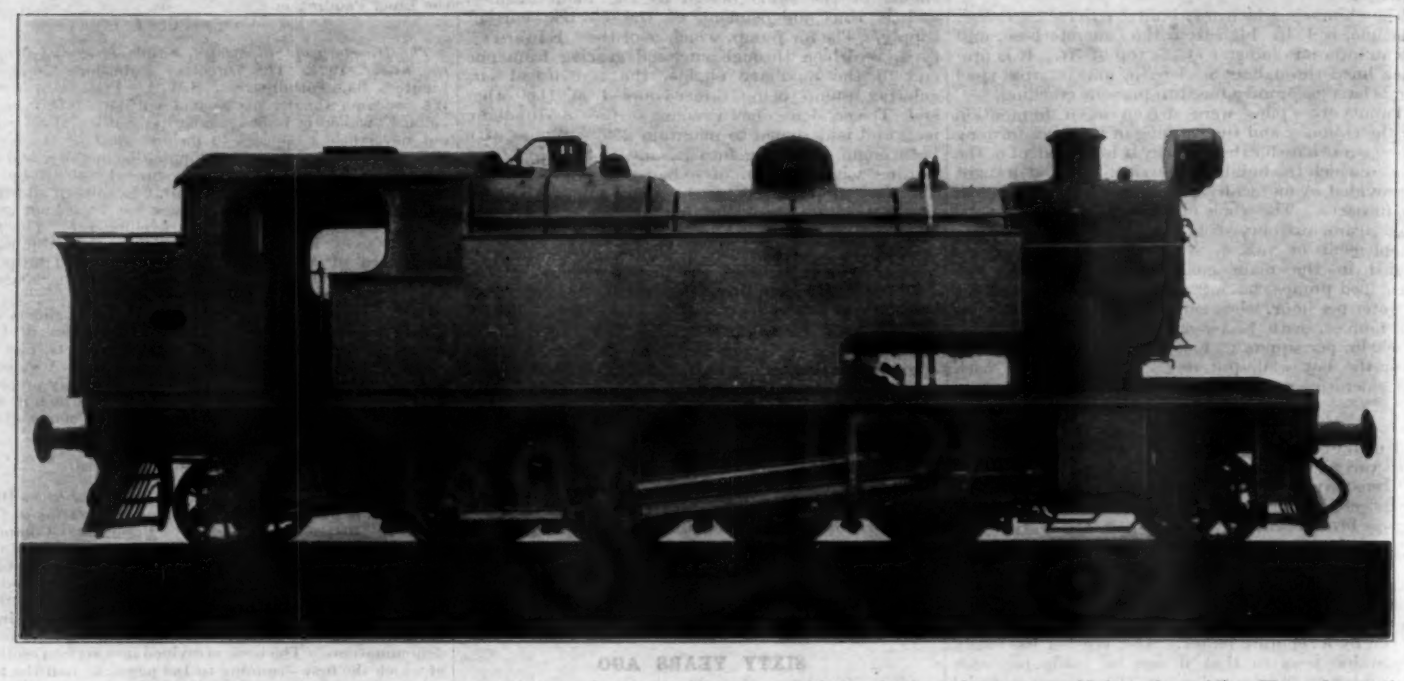
The Advertisers' A B C, 1924. London: Compiled and published by T. B. Browne, Limited, 163, Queen Victoria-street, E.C. 4.—We have just received the thirty-eighth annual volume of this directory. The book is divided into ten sections. The industrial economics of advertising are treated at length. Pictures and letterpress of some British, colonial and foreign advertisements which have been successful are included. One section is devoted to a complete index and classified lists of the publications of Great Britain and Ireland, whilst practically every newspaper and periodical published in the world is chronicled. In fact, the volume is full of valuable information to all who have anything to sell.

Official Chemical Appointments. London: The Institute of Chemistry of Great Britain and Ireland, 30, Russell-square, London, W.C. 2.—This book, which is now in its fifth edition, has been compiled by direction of the Council of the Institute of Chemistry and under the supervision of the Publications Committee by the Registrar of the Institute. Its object is to provide a full list of official appointments which are or may be held by chemists. Much new and valuable information has been collected together, and incorporated in the volume, which should prove extremely helpful for reference.

Directory of Paper Makers, 1924. London: Marchant, Singer and Co., 47, St. Mary-axe, E.C. 4.—This directory, now in its forty-eighth year of publication, has been thoroughly revised and brought up to date. It contains full particulars of the paper makers of the United Kingdom, and lists of mills alphabetically arranged under the names of the occupiers. A list of paper enamellers, surfacers, gummers, &c., is also included. Trade names, watermarks and much other valuable information in connection with paper may be found in the volume, which is published at 5s. net.

EAST INDIAN RAILWAY, EIGHT-COUPLED SHUNTING TANK ENGINE

BEYER, PEACOCK AND COMPANY, LIMITED, MANCHESTER, ENGINEERS



East Indian Railway 2-8-2 Shunting Tank Engine.

An addition to the standard designs for the Indian railways has recently been made by the construction at the works of Beyer, Peacock and Co., Limited, Gorton Foundry, Manchester, of a number of powerful eight-wheels coupled tank engines for the East Indian Railway. The locomotives are intended expressly for shunting the heavy goods trains brought in by the main line locomotives.

Although superheated steam is not used, the cylinders have piston valves and automatic by-pass valves are fitted. The valve motion, which is of the Walschaerts type, is controlled by screw reversing gear. The weights of all revolving and reciprocating details are kept as light, and the coupling and connecting-rods are of fluted section. All details are made duplicate with existing standards where possible.

The boiler is of the Belpaire type, designed for 180 lb. pressure, but working at 160 lb., with a smoke-box of the drum pattern carried on a cast steel combined saddle and frame stay between the cylinders. The injectors are of the Gresham and Craven pattern. They are placed behind the footsteps and deliver to clack-boxes on the top of the barrel.

The frames are of plates in one piece, stayed with steel castings. The eight-coupled wheels have a short wheel base to facilitate working the engines through the sharp curves of goods yards, and the ponies are of the radial arm swing link type.

The principal dimensions of these engines are as follows:

Cylinders	22in. by 26in.
Wheels, coupled, diameter	4ft. 3in.
Wheels, truck, diameter	3ft.
Wheel base, rigid	14ft. 6in.
Wheel base, total	31ft.
Boiler heating surface—	
Tubes	1417.5 square feet
Fire-box	150.0 square feet
Total	1567.5 square feet
Grate area	27.0 square feet
Tank capacity	2000 gallons
Bunker, coal	4 tons
Weight in working order—	
Adhesion	67.2 tons
Total	90.43 tons

These engines have been built to the specification and under the supervision of Messrs. Rendel, Palmer and Tritton, the consulting engineers to the India Office.

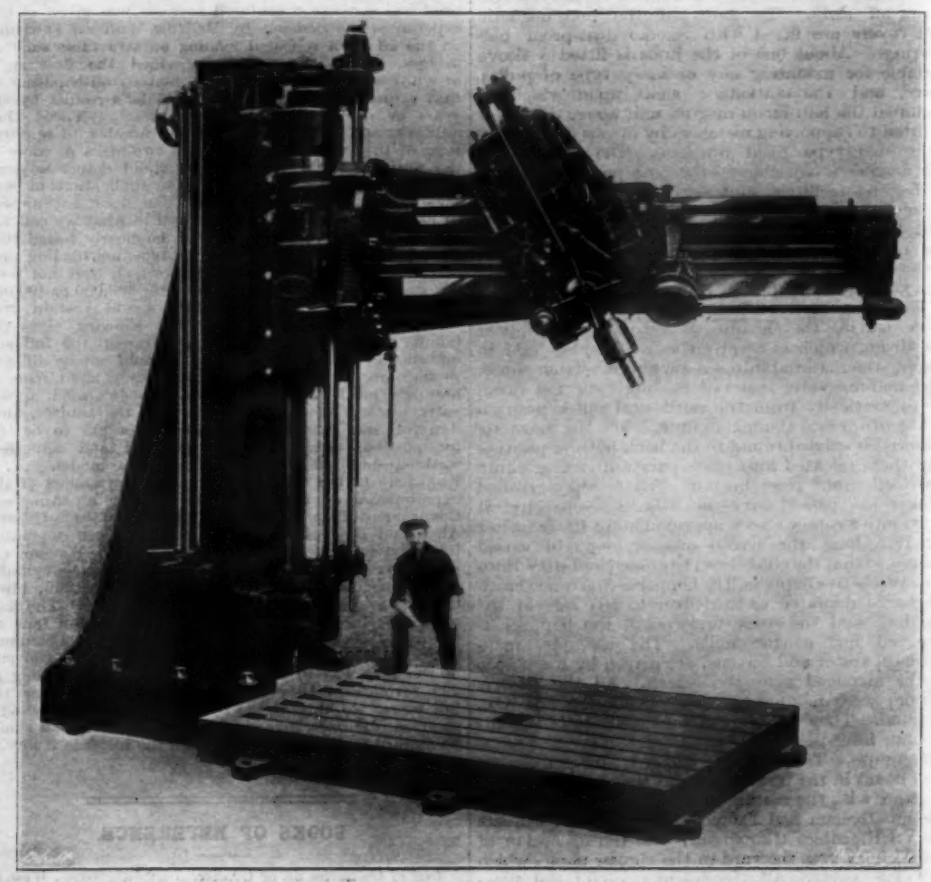
Large Radial Drilling, Tapping, and Studding Machine.

The very large radial machine illustrated herewith has recently been constructed by William Asquith (1920), Limited, Halifax. Some idea of its size will be gathered from the dimensions and weights of the leading parts. The base plate measures 21ft. by 8ft. and weighs 9 tons 10 cwt., the column measures 10ft. by 8ft. by 6ft., and weighs 12 tons; the arm measures 14ft. 6in. by 5ft. 6in. by 5ft. 6in., and weighs 5 tons 5 cwt.; the sleeve in which the spindle revolves measures 15ft. 3in. by 4ft. 6in. by 3ft. 6in., and weighs 7 tons, and the total approximate net weight of the machine is 40 tons 8 cwt. The maximum radius of the spindle, taken from the centre of the column on which the arm swings is 11ft., and the distance from the spindle to the base-plate can be varied between 4ft. 6in. and 9ft. 6in.

In this machine the balancing of the spindle is accomplished by an improved method, which comprises a weight carrying a steel rack of the same pitch as the feed rack on the spindle. Meshing with both these racks is a balance pinion which ensures that when the spindle is fed down the weight rises and *vice versâ*. The spindle can be started, stopped or reversed by means of friction clutches, controlled by a lever placed on the right side of the saddle, and the feed of the spindle is obtained through a steel rack and pinion, worm and worm wheel running in an oil bath. Eight rates of positive speed are available through steel and phosphor bronze gears, and changes of feed can be effected instantly without stopping the spindle. The self-acting feed operates through an improved friction arrangement instantly applied or disengaged.

In addition to the self-acting feed there are provided a fine hand feed operated by hand wheel, as well as quick hand adjustment. An automatic trip device is fitted to the feed motion with an index dial and safety stop for preventing over traverse and for drilling holes of predetermined depth. The saddle or spindle slide is arranged to swivel by worm gear through 85 deg.; 45 deg. pointing outwards and 40 deg. with the spindle pointing inwards towards the pillar. The traversing of the saddle along the arm in either direction is effected either by power or hand motions through steel screws. The power motion can be reversed easily by a lever on the saddle, and the saddle can be securely clamped to the arm in any position. Single, double and treble gear controlled by a lever in front are provided on the saddle. These three ratios of gearing permit of a wide range of speeds and enable the machine to cope with large diameter tapping, boring, &c., in addition to ordinary high-speed drilling.

The arm is built in two sections, one part bearing on the cylindrical sleeve and capable of being securely clamped thereto in any position. The other portion of the arm is of double tubular section designed to give the maximum resistance to lifting and twisting strains. This portion carries the drilling saddle, is accurately fitted to the portion bearing on the sleeve, and has a rotary movement through 180 deg. by means of worm gearing operated by a ratchet lever in front. The arm can be securely clamped at any angle. The raising and lowering of the arm is effected by power motion controlled by a lever at the bottom of the sleeve. The sleeve is of large diameter accurately ground, and is firmly supported at the top and the bottom by strong brackets securely bolted to a heavy pillar. The pillar is of extremely strong construction, ribbed to resist all stresses consequent upon heavy drilling, and is bolted to the base-plate. The gear-box is placed at the top of the pillar and the levers for changing the speed are brought down to the bottom so as to be convenient for the operator.



RADIAL DRILLING, TAPPING, AND STUDDING MACHINE

BELGIUM'S INDUSTRIAL FUTURE.

In the course of an interview with a recent representative of the *Journée Industrielle*, M. Paul Hymans, the Belgian Foreign Minister, said that he had a profound and absolute belief in Belgium's industrial and commercial future, based, not on illusions and extravagant hopes, but on realities and statistics. When the Armistice came, said M. Hymans, Belgium was full of misery and destruction. The railways were disorganised, the canals blocked up, bridges destroyed, factories demolished, shops empty, and the ports closed. *Now*, the total of Belgium's exports exceeded four-fifths of her imports, and the movement at the port of Antwerp was 15 per cent. greater than before the war. Moreover, the production of 1913 had been exceeded at the coal mines, the coke works, in the iron and steel industry, &c.

There was no unemployment in Belgium. The factories were able to absorb all the labour available, and new works were springing up to supply products for which Belgium had previously been dependent on foreign nations—copper, tin, cobalt, and radium, for instance.

This, continued the Minister, was not all. Belgium had other sources of riches and prosperity. Situated between great nations, the commercial exchanges of which would gradually recover their former dimensions, she would benefit as in the past by the immense traffic passing through her great port, the most frequented in Western Europe, and over her railways, the densest system on the Continent. Then, again, as had been noted only the other day by the British commercial attaché at Brussels, one of Belgium's chief resources was undoubtedly the capacity for hard work of the Belgian people. Finally, there were two sources of riches which were at present almost unexploited, but which offered practically unlimited possibilities: the Campine coalfields and the Congo Colony. As regarded the former, experts reckoned the quantity of fuel available at 8000 million tons. Some mines were already working, and the output was constantly increasing. These, concluded M. Hymans, were the realities to which he had alluded, and in spite of the present difficulties, which were great in every country, he thought that they were sufficient to justify the confidence he had expressed.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Improved Market Tone.

The tone of the Midland iron and steel market is more cheerful than it has been for some time. Business shows some signs of increased movement, though the buying is of a spasmodic character. There is undeniably an underlying strength which is trying to assert itself. It is held in subjection, however, by conditions antagonistic to the consolidation of the position. Trade is disturbed by the attitude of labour. Neither producers nor consumers are prepared to commit themselves ahead, and the hand-to-mouth buying which results, creates an atmosphere of insecurity which is opposed to a lasting trade improvement. Even though consumptive demand is expanding, confidence is repressed. Selling prices certainly are showing a pronounced upward tendency, but this rebound from the very low figures which in certain instances have been accepted is favoured by the conditions now prevailing on the Continent. Since the franc regained a stronger position, there has been very little business done in French and Belgian iron and steel. Too much significance must not be attached to this, however. There is still a big tonnage coming in against old contracts, and many consumers expect to be able to buy again on favourable terms before their incoming supplies are at an end. This being the case, buyers are not purchasing material from local firms beyond what they require for immediate needs. Underselling has not entirely disappeared, though the more conservative among the producers are no longer tempted to enter into a war of prices without reference to production costs. The tendency to higher prices runs through raw iron and semis into finished material.

Steel Position Progresses.

The position of steel has improved, though largely through the relaxation in foreign competition. Hardly any foreign steel is on offer, and the poor deliveries compel a good deal of business to be placed at home, which, if prices were solely considered, would go to Belgian steel works. Steel business has an expanding tendency. Several contracts have been placed for pipe-making material. A lot of plates have been ordered for boiler building and repairs. For the time being, railway buying is not a conspicuous feature, but the lines are short of rolling stock and much more business is expected to be placed shortly. A lot of new work is pending on home and foreign account, which, it is thought, will be placed if labour troubles can be got definitely out of the way. While there is still some irregularity in steel prices, the disorganisation is not so widespread as it was a few weeks ago. Billets have been gradually firming up in view of the abatement of serious competition from the Continent. Apart from one firm, sellers are not prepared to accept less than £8 5s. for British billets. In some cases £8 10s. is required. The increased tonnage of orders placed appears to suggest improving confidence, though the quantities of orders are not large. There is also an improved feeling as regards prices of sections and joists. Small steel bar quotations have moved up. Many rollers this week ask up to £10 5s. It is almost impossible to get supplies at last week's figure of £9 15s. Steel scrap is in somewhat better demand, though prices are kept low by the large consignments still received from the Continent.

Crown Bar Prices Advanced.

Many Staffordshire ironmasters have been barely able to make ends meet for many months now, and they have been endeavouring to improve the price of their products. It was to be expected therefore that makers of Crown bars and nut and bolt bars would follow the lead of the marked bar houses and advance their quotations. Staffordshire, Lancashire and Yorkshire Crown bar prices are now placed on the basis of £13 per ton, though it is still possible to negotiate contracts below this figure. Endeavours are being made likewise to increase the price of nut and bolt bars, but in this department they are not meeting with so much success. Makers' quotations have advanced 5s. per ton to £11 15s. to £12, but buyers are not responsive and very little business is being done. Iron strip has continued to appreciate, £13 5s. being the basis, with some mills pressing for rather more. The bulk of the business in Staffordshire is for best iron, but the demand for medium material shows improvement. Country orders are well maintained, but the prospect of new business is diminished somewhat by the rise in prices.

Raw Iron Values Firmer.

Pig iron contracts have become heavier, and Staffordshire bar makers have been buying forge material rather more freely than for some time. Makers of raw material are reluctant to take forward commitments in view of the great uncertainty as to fuel charges following the coal settlement. But they prefer to take risks rather than to turn down business. Prices have hardened following the recovery in Cleveland, and there is no difficulty in maintaining the standards of £4 15s. for Derbyshire foundry and £4 12s. 6d. for Northamptonshire iron. The exceptionally low prices which were entertained by smelters a few weeks ago no longer apply. In particular makes of pig iron the price level is now 1s. to 1s. 6d. above the worst. Late quotations stand. The difference is that they represent a more uniform basis of actual business than was formerly the case. The high price of fuel is a strong element in promoting the firmness of the market.

Reduced Sheet Prices.

Galvanised sheet prices have receded further during the week, and makers in this district generally now quote £17 10s. per ton for galvanised corrugated sheets of 24 gauge. This price, which is a fall of 5s. per ton on the week, applies alike to home and to export business.

McKenna Duty on Foreign Motor Cars.

The Chancellor of the Exchequer's attitude to the Safeguarding of Industries Act has aroused great anxiety in Midland motor engineering circles with regard to the McKenna duty on imported foreign motor cars. Under the fostering influence of this duty—one-third of the value of the goods concerned—the huge motor engineering firms in this district have been enabled to keep their works employed, and solely to the protection afforded them by this duty do they attribute their success during the great trade slump in keeping their plant going. The McKenna duties are not part of the Safeguarding of Industries Act. They need re-enactment in every Budget, and if Mr. Snowden drops them in his coming Budget the effect on Birmingham, Coventry and other Midland towns will, it is considered, be nothing less than disastrous. The report current this week that a decision has been arrived at by the Government not to renew the duty is viewed with the gravest concern, especially in Coventry. No other city can be pointed to as affording so striking an example of the value of some form of protection to British industry, for between the end of 1921 and December last, unemployment in Coventry decreased by over 60 per cent., as compared with an average reduction of 32 per cent. for the whole country. At the moment, as I pointed out in a recent letter, the Coventry motor engineering industry is enjoying, if not an actual boom, a period of great activity, with many of the works running day and night. But if the duty on foreign imported motor cars is allowed to lapse at this juncture, it will, in the opinion of the leading motor engineering firms, utterly disorganise Coventry's premier industry.

Edge Tool Industry.

The edge tool industry in this area is experiencing a good run of business just now, and works are generally fully employed. The seasonal demand, though late in materialising, is now stated to have come up to expectations, while reports go to show that the orders received lately from overseas markets have improved in number and volume. Prices are steady, though the increase in raw material prices, if continued, is likely to affect edge tool values. The outlook is considered fairly bright.

Unemployment Decrease.

The returns prepared by the Ministry of Labour show a further decrease in the number of persons unemployed in the Midlands. The returns issued last week gave the total of unemployed as 121,666, and those prepared for the week ended April 7th show a decline of 949 to 120,717. The number is distributed as follows:—Men, 86,725; boys, 1872; women, 29,202; girls, 2918.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

There is a little improvement to be noted in some sections of the iron and metal markets, but so far it is rather indefinite, and perhaps more in feeling than in anything else, except with regard to the foundry iron trade, where there is more buying. The question of the coal stoppage is, of course, by no means settled by the majority of votes against the offer of the masters. A very much larger majority will be necessary if a strike is to take place, and on the whole the situation is rather more favourable than it was now that it is known that so large a minority voted for accepting the terms offered; but, of course, trade must remain in a very uncertain condition until it is positively known whether or not we are to have a stoppage. The continental position in the iron trade is also rather precarious, depending, as it does, on whether or not the improvement in the currency values can be maintained.

Metals.

One of the safest markets at the present time seems to be copper. Although, of course, no one can say that copper prices will not again recede, the chances seem to be far more in favour of a moderate advance than of any fall from present levels. The position in America seems fairly steady, and although plans for the reduction of the output are counterbalanced to a certain extent by new copper producing plants, yet on the whole the output is lessened, while there is apparently no diminution in the rate of consumption. On this side there is certainly some progress being made towards re-establishment of industry in Europe. German consumption is slowly recovering, and the stabilisation of the exchange makes business with that country more practicable. The French demand is also rather better. In this country consumers of copper are, for the most part, still working on rather small stocks, and if any serious confidence in the market should set in there is little doubt that consumers would soon begin to hold very much more metal. The relatively high prices for manufactured copper and brass, such as sheets and bottoms, locomotive and condenser tubes, &c., militate against the holding of larger stocks of these materials; but there cannot be much risk in holding best selected or tough ingot copper at the prices quoted recently. The scrap metals are still to be bought on favourable terms from dealers, and particularly scrap gun-metal. Quite good mixtures are now being bought by the dealers at £48 per ton, and in some cases at £47, although, of course, their selling prices to the consumer are higher. For all work where an exact specification of the component parts or the mixtures is not required these scrap materials afford an opportunity of saving in cost. The market for tin continues to be very irregular and uncertain. The last setback seems to have been caused mainly by doubt as to the American demand. The market had for a long time relied upon a large demand from the United States, and if by any chance that should fail, no doubt the general level of prices would be lower; but is there any probability of any such failure beyond a very temporary cessation of buying? The original cause of the collapse in the tin market was the enormous loss by speculators in France, and the effect of this must now be passing off. The market for lead has been rather quieter of late, and some people think that the price is now settling down at round about £34 for foreign and £35 for English metal. These prices are, of course, high when considered relatively to copper or spelter; but unless the production of lead can be very much increased to meet the heavy demand, it will be impossible to get back to the old relative values. Spelter remains rather weak and the demand at present from consumers here is rather poor.

Pig Iron.

The market for foundry iron in the Manchester district is a little better, and there is an increasing disposition to buy for delivery over the current quarter. The reason of this, as has been already pointed out, is the growing conviction that foundry iron in Manchester cannot be any cheaper and may be dearer before the end of June. Midland makers seem to be fairly confident that they will be able to obtain rather more than the present lowest price a little later on, and as a consequence they are in no hurry to sell. Some of the Derbyshire makers have already raised the furnace price to 96s. per ton and others to 96s. 6d., making the delivered price in the Manchester district 103s. 6d. to 104s. per ton; but Derbyshire No. 3 can still be bought here, at any rate up to May 31st, at 102s. 6d. Cleveland iron, on the other hand, would cost fully 107s. 6d. per ton in Manchester, and if the reports from that district are to be believed, there is very little No. 3 now available and practically no No. 1. Of course, the Cleveland price depends entirely upon whether the Scotch and continental demand continues to be as brisk as it is at present, and this again depends upon the stability of the French and Belgian exchanges; but in any case Cleveland No. 3 is not likely to fall to 90s. per ton at the furnaces within the next two months; and unless it does, it cannot compete in Manchester. Scotch iron is rather firmer here at 114s. to 116s. 6d. per ton delivered, and merchants report a rather larger business. This may mean that the textile engineers are taking a more favourable view of business prospects, although one cannot think that the cotton trade here has yet much spare capital to invest in new machinery.

Steel.

Some of the selling agents for steel manufacturers report a better inquiry, mainly for small lots of finished steel; but so far the prices here do not seem to respond. For joists and angles delivered in Manchester £9 15s. is still quoted, and possibly business could still be done at £9 12s. 6d., but one does not hear of £9 10s. any more. For round bars the usual price now is £10 to £10 15s., and for flat bars £10 5s. Plates are somewhat neglected, but sellers usually quote £10 5s. per ton.

Scrap.

The market for scrap of all kinds remains rather dull and weak. The fact that Lancashire bar iron was raised 10s. to £13 per ton for Crown quality ought to stimulate the demand for heavy wrought scrap at £5 per ton, for it is a cheap material as compared with forge pig iron; but this week there is not much indication of a better market. The demand for cast scrap is still rather poor, but dealers continue to quote from 87s. 6d. to 92s. 6d. per ton delivered and according to quality. For steel scrap there is no demand and the prices offered by the dealers for lots in Lancashire, delivered on trucks, are very low—say, from 70s. to 72s. 6d. per ton.

BARROW-IN-FURNESS.

Hematite.

The state of the hematite pig iron trade in this

district remains about the same, and there will be no alteration until the miners' troubles are settled. Then, too, the shipyard lock-out has a disturbing influence on trade generally, but it is not expected to last any length of time. Stocks do exist in the district, but not to any marked extent, and although the consumption by the steel departments is not on anything like a large scale, the demand is sufficient to take the limited output without the tonnage lying at the makers increasing to any extent. It would seem as if all the smelters were keeping down the output to the lowest, so that when they meet the improved trade they will not be saddled with heavy stocks. There are signs of the continental trade improving, and this is due solely to the fact that the appreciation of the franc is bringing hematite within the reach of buyers in France, Belgium, &c. If the franc gets to 70 the prospects will be even better. At present the Midlands are the best customers. A moderate amount is going to Scotland, but this business will improve as soon as the air is clearer. Now that there are direct sailings from Barrow to Philadelphia, with possibilities of extensions to Baltimore and Boston, there is some hope of the American business improving, as part cargoes are quite a different proposition to chartering a vessel or having to send pig iron by coasting steamer to Liverpool for transhipment.

Iron Ore.

The local iron ore trade is dull, and likely to be until there is more life in the iron trade. None of the mines are active and many are doing nothing at all practically. Foreign ore continues to come in, and Carnforth has been receiving a fair tonnage *vid* Heysham. Moderate cargoes have been received at Barrow at intervals.

Steel.

The steel trade remains quiet, although there are several inquiries, but none of them bulk heavy. The Workington rail mills have gone on this week on a rush order, but it will only keep them engaged for the week. The Barrow rail and merchant mills are still idle, and there is no talk of them re-starting at the moment. The hoop and section mills are better situated and have orders to keep them going regularly.

Shipbuilding and Engineering.

The lock-out has affected Barrow to the extent of a thousand men or so, but this stoppage will not hold up work for some time, and in the meantime it is hoped that the trouble will be settled. The shipyard is fairly well employed and there will be one or two important launches in the course of the next two or three months. No fresh orders are reported, but we may be hearing something about new work in the early future.

SHEFFIELD.

(From our own Correspondent.)

More Trade, but Little Profit.

There is a better tone in the heavy steel trade, so far as amount of work is concerned, but complaints of the unremunerative character of business are pretty general. There is no actual improvement in the booking of new contracts for open-hearth steel, but the decline in foreign competition is a cheering sign. This decline is due largely to the fact that prices of continental billets, bars and sections have risen to such an extent that the British user gains nothing by sending his orders abroad. It rather looks as if British makers will have to follow suit in the matter of prices. They have already raised their charges for bar iron and soft billets, and the prospects of dearer fuel and raw materials are causing anxiety. At the same time, competition among the home firms themselves is extremely keen. There are numerous instances of slackness, and many gaps to fill up, and under these conditions price cutting is resorted to in order to secure orders.

Railway Work.

The departments engaged in the manufacture of railway steel continue busy. The Duke of York, during his visit to the city last week, was taken to a typical works—those of Samuel Osborn and Co., Limited—where he saw, among other things, springs being made for the Buenos Aires Great Southern Railway and the Avonside Engine Company, Limited, carriage bearing springs for the Great Indian Peninsula Railway, tramcar springs for the Brush Electrical Engineering Company, Limited, locomotive springs for the London and North-Eastern Railway Company, as well as motor omnibus, standard wagon bearing and standard wagon buffing springs. The manufacture of manganese steel points and crossings for tramways and railways is an industry in which Sheffield was the pioneer, and which now occupies a very important position in the city. Three firms specialise in this work, and they are fairly well off for orders for the home market, the Colonies, Sweden and South America. The railway programmes are also benefiting Lincoln, where Clayton Wagons, Limited, have secured an order from the London and North-Eastern Railway Company for sixty bogie carriages for the main line of the railway. The carriages are to be fitted with the Gresley articulated type of bogie, and are of the most up-to-date design. It is announced that altogether the London and North-Eastern Company is giving out contracts of a value of about £600,000, which will be distributed among half a dozen Midland firms.

The Lighter Steel Trades.

There is no improvement to record with regard to the condition of the crucible steel trade. It is still suffering from the loss of the continental markets, and is in a very slack state. There is an extremely poor demand for the various alloys used in the composition of special high-grade steels, although the prices are very low, some of them having reached pre-war level, which, it is said, is insufficient to cover production costs. A much more satisfactory report comes from the saw trade, which appears to have completely emerged from the slump of the last few years, and is now very busily employed, especially on circular saws. In the case of one of the largest firms, a twenty-four-hour day is being worked, and, although others are not working under such great pressure, employment generally is so good that the whole of the available skilled labour has been absorbed. The activity is to a considerable extent due to orders from Japan for circular saws for wood cutting, to be used in the rebuilding of the towns which were devastated by the earthquake. Many of these saws have a diameter of as much as 6ft. or 7ft. An excellent opening was recorded in the season for farm and garden tools, and orders were received in large volume, but a falling off is now reported. The implement trade is making but moderate demands for steel parts.

Cutlery.

There is not much improvement in the state of this trade, taken on the whole. A large demand is maintained for table cutlery, chiefly for ships, railways, hotels, cafés, stores and advertisers, and firms which have booked contracts for these supplies are fairly well situated. The ordinary home trade, however, has been showing a falling off all the year, and travellers calling upon provincial shopkeepers bring back very unsatisfactory reports. The colonial trade is not so bad, and some useful orders have come to hand lately, while South America is also sending business through. There is a continuance of keen competition in the stainless knife department, but the leading makers are determined to maintain their quality, holding that any reduction in that respect, although it might serve to secure orders at the moment, would prove to be unsound policy in the long run. French competition in table cutlery is increasing, especially in Canada, where knives are being offered at prices lower than the British, but H.M. Trade Commissioner in the Dominion reports signs of a growing demand for British goods, due partly to a greater realisation of the value of quality.

Coal under Sheffield.

There have been many colliery developments in the district surrounding Sheffield, and now there is prospect of similar progress within the area of the city itself. It will not be on a very large scale, but it is very interesting by reason of the fact that the scheme has led to the first application under the Mines (Working Facilities and Support) Act, 1923. Last week the Nunnery Colliery Company, Limited, of Sheffield, appeared before the Railway and Canal Commission to apply, under Sec. 5 of that Act, for permission to work minerals under the city of Sheffield. It was stated that the area affected was about 200 acres of the Silkstone seam, and 400 acres of the Parkgate, adjoining the minerals at present worked by the company, which has been in existence since 1874. The several ownerships ran into thousands, and the minerals were in such exceedingly small parcels that it would be impossible conveniently to work them by themselves. Counsel for the company put his application on the grounds of the output of coal in the area; that this coal was claimed to be the best bituminous coal in the country; that its working would result in increased employment; and that if the present company did not make this application the coal would never be worked in the future, because the area was too small for any other company to sink shafts—it would not be worth their while. He added that the Sheffield rates would be assisted to the amount of £10,000 annually during the time the seams were worked, and that it would be impossible for any injury to be done to the surface. Mr. Justice Sankey directed the publication of notices calling upon objectors to send their reasons to the Registrar, after which the Court will give an order as to who should appear, and will decide whether a local hearing in Sheffield is necessary.

Colliery Devices.

An interesting exhibit at Wembley Park will be a 5 horse-power patent mine haulage gear, made by David Ashton and Co., Limited, of Aztec Works, Neepsend, Sheffield, and known as "Little David." The machine is totally different from the ordinary kind of such appliances in that the electric motor is mechanically interlocked with the friction clutch. The machine on view will be fitted with a 5 brake horse-power squirrel-cage induction motor, direct coupled to the epicyclic gearing, which is contained within the haulage drum. Messrs. Ashton have supplied a number of these little machines to collieries in the North of England. They are displacing pit ponies, each machine doing the work of four or five animals. Another interesting mining matter is the prevention of accidents due to trains of corves running away, to which a great deal of attention has been devoted recently. A number of safety appliances have been devised and tested, and now the matter is to be thoroughly gone into at the University. Mr. I. C. F. Statham, of the Mining Department of that institution, is carrying out research work, and will next month read a paper on the subject before the Yorkshire branch of the Association of Colliery Managers. An incline will be arranged in the University yard, where demonstrations of the working of the various appliances will be given.

Developments at Askern.

Sir Samuel Instone, chairman of the Askern Main and other collieries, performed the ceremony of opening the Askern Miners' Institute. The building was formerly a well-known hydropathic establishment, and has been acquired by the Miners' Welfare Committee. Sir Samuel remarked that the colliery company had already spent £200,000 over and above the price paid for the colliery. It was erecting coking and by-product plant, costing another £200,000, and on top of this there was in course of erection a washing plant costing £30,000.

Municipal Schemes.

Several interesting municipal projects are afoot in the district. Rotherham Corporation, which has a Bill in Parliament, is seeking permission to insert a new clause by which it proposes to take power to make a new service reservoir on lands lying to the south of Wortley-road, and adjoining the existing service reservoir. Barnsley Town Council has decided to embark on a scheme of repairs to water mains, to be carried out in six years, at a total cost of £16,000, and it is also announced that the first sod of the Scout Dyke reservoir will be cut during the first week in May.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Shipyard Lock-out.

The lock-out in the shipyards on the North-East Coast, forced upon the employers as the result of the obduracy of the Southampton shipyard workers, who for seven weeks have been engaged in an unauthorised strike for increased wages, comes at a time when the industry was just settling down after prolonged depression. Employers in this district express their regret that drastic action has had to be taken, and among the men themselves there is a good deal of irritation at the fact that a settlement was not reached before the stoppage occurred. It is not likely, however, that there will be any immediate serious effect upon the construction of ships in North-East Coast yards, as some very important unions are not concerned, and their members are at work. The principal "key" union under this head is the Boilermakers' Society, which was the central figure in the lock-out of last year. So far as this area is concerned, there is also the fact that the labourers in the yards—for the most part members of the National Amalgamated Union of Labour—are not locked out. The members of the Shipwrights' Association are also at work. Generally, therefore, the constructional men in the industry are not affected, and vessels will have to be in a very advanced state before the absence of the locked-out crafts becomes serious. It cannot be denied, however, that the lock-out will have a very prejudicial effect on the future of the shipbuilding and ship-repairing industry, as owners who were inquiring for tonnage have been deterred from continuing those inquiries, and those with vessels needing repairs are hardly likely to send them to yards which may be unable to complete the work at a given time. Continental ship-repairing centres will undoubtedly benefit. It is estimated that about 6000 men have been locked out in this district.

Cleveland Iron Trade.

Business in the Cleveland pig iron trade has not been quite so brisk during the past few days, but this is only to be expected after the recent heavy transactions, and in view of the approach of the Easter holidays. A fair number of inquiries are still circulating, however, and indication is not lacking that steady trade is likely to continue. A growing feeling of confidence in the situation is gratifying, and if labour troubles do not hamper matters there appears to be good reason to anticipate a gradual all-round improvement. The home demand for pig iron is expected to expand, and continental requirements are believed to be still far from fully satisfied, so that, with the products of this district cheap as compared with those of other home localities and iron centres abroad, prospects may be regarded as distinctly more encouraging than for some time past. No. 3 G.M.B. Cleveland pig iron is 92s. 6d., No. 1 97s. 6d., No. 4 foundry 91s. 6d. to 92s., and No. 4 forge 91s. to 91s. 6d.

Hematite Pig Iron.

The hematite pig iron trade is also quieter, steel makers taking reduced quantities in consequence of the holidays. Makers, however, are hopeful of better business after Easter. In the meantime, there is an easier tendency in prices, and mixed numbers are obtainable at 99s. per ton, both for home use and export.

Iron-making Materials.

Foreign ore merchants report an absolute stagnation in business, and so far as can be gathered market quotations, based on best Rubio at 24s. c.i.f. Tees, are purely nominal. Good Durham furnace coke is still obtainable at 30s. per ton delivered at the works.

Manufactured Iron and Steel.

The outlook in the manufactured iron and steel trade is improving. Prices are now such as to admit of successful competition with continental makers, with the result that customers are taking a good deal more interest in this market. Whilst the volume of trade passing is not heavy, a few useful contracts have been arranged, and hope is entertained that substantial orders, which have been held up, will be released. Values show little movement. In some departments there is a slightly firmer feeling, but the only actual advance is a rise of 10s. in iron bars, which now become £12 10s.

The Coal Trade.

The outlook in the Northern coal trade is unsettled, as there are many doubtful factors. The main position, of course, centres on the developments in the miners' negotiations. The result of the ballot appears to give the hope that a friendly settlement will be reached, and that for some weeks the prospect of steady work at the pits is assured. Merchants consider that the vote, although against acceptance of the owners' terms, showed so small a majority that negotiations should result in a continuance of work, and that it practically amounts to acceptance of the generous terms offered by the coal-owners. While the question of a stoppage is generally placed in the background, the fear of it still has a sentimental effect on coal prices, and there is no disposition to enter into any large commitments for forward periods until further meetings have been arranged, and a more definite lead given as to the direction of the negotiations. The undertone of the market is easier than it was during the past two or three weeks, but the prices ruling during this latter period have been mostly dictated by *force majeure*. Prospects point to a return of more normal values, and, as sellers continue to ask late prices, there is a margin of from 1s. to 2s. per ton in views as to various

grade values. The possibility of a stoppage in the Ruhr coalfields, owing to the working agreement with the miners automatically ending this month, has resulted in a good deal of inquiry for supplies from the Continent. German buyers are evidently taking a serious view of the Ruhr position, as they are inquiring freely for supplies and for early shipment, offering full current value. The demand for all qualities of coke is rather slow, but makers are not pressing supplies on the market, and values remain fairly steady.

Cleveland Miners' Wages.

An advance of 0.5 per cent., bringing wages from 84½ to 85 per cent. above base rates, was agreed upon by the Cleveland ironstone mineowners and the miners' representatives at a joint conference on Monday.

SCOTLAND.

(From our own Correspondent.)

The Shipyard Trouble.

So far as the Clyde is concerned the shipyard lock-out is not calculated to affect the position to any great extent in the meantime. The workers concerned in this area number between five and six thousand only, including the joiners. The shipwrights and the various trades organised by the Boilermakers' Union are not involved. Although the painters are affected nationally, only those employed in English yards are locked out, as the Scottish Painters' Union is not involved in the Southampton dispute. On the Clyde the coppersmiths were chiefly engaged on repair work, while so far as the Transport Workers' Union was concerned, none of its members were employed on the Clyde. The apprentices have been allowed to remain at work.

Shipbuilding Contracts.

It is reported that a firm on the lower reaches of the Clyde is to build a cargo-passenger vessel of 5000 tons for foreign owners, and that Alex. Stephen and Sons, Linthouse, have an order for a fruit-carrying vessel of 2500 tons. Another vessel similar to the latter is to be built by Lewis and Sons, Limited, at Aberdeen. J. G. Kincaid and Co., Greenock, have an order for a set of Diesel engines to be constructed on the Burmeister and Wain-Harland and Wolff principle. This machinery is to be fitted to a vessel of 8000 tons now under construction on the Clyde. The main engine, which is to be of the long-stroke crosshead type, is to have six cylinders, each 740 mm. bore by 1500 mm. stroke, and is to be capable of developing a normal power of 1750 brake horse-power continuously in service when running at 85 revolutions per minute.

Pig Iron.

The pig iron market showed a tendency towards improvement during the past week, and a slightly firmer tone was noticeable. The business passing showed little or no increase, however, as consumers are not at all disposed to anticipate requirements at present. At the moment the export demand seems more likely to expand than the home demand.

Steel and Iron.

An improvement in the steel trade is still delayed. Labour troubles are undoubtedly retarding the placing of fresh business, and in the meantime the steel works have great difficulty in maintaining employment. Few makers have more than sufficient specifications to cover operations a week ahead. Plates are especially slow. Sheet makers are still comparatively well placed, however. Export demands are fair and outputs are moderately satisfactory. Home prices are all unchanged. Bar iron makers are not receiving much support. Old orders are being worked off and the amount of fresh business booked is very disappointing. Consumers, of course, are anticipating cheaper prices and practically nothing beyond absolute necessities is bought. Re-rolled steel is a shade more active, but business is only possible when considerable price concessions are granted.

Coal.

The coal trade in general shows little change since last week. The pressure for inland supplies is maintained and foreign inquiries are broadening out. France, Belgium, Scandinavia, and Germany are all likely buyers. The labour uncertainty and the great scarcity of fuel dominate the situation at present. The collieries in all districts have heavy bookings and have really nothing to sell this month at least. Consequently operations on the market are practically confined to the turnover in second-hand lots with prices pretty much a matter of arrangement. The coal trimmers' strike is not over yet, and there is some talk of the movement spreading. Fuel from Fifeshire is being shipped through Glasgow to the South of England. West of Scotland fuel has gone in fair bulk to the Irish market. Inland consumers, however, are snapping up practically all the fuel coming on the market and shipments are almost entirely against old contracts. Prices are very firm, but under the circumstances only approximate quotations are possible.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE result of the miners' ballot on the coal-owners' offer to settle their wages demands affords comfort, inasmuch as the prospect of a national strike in the coalfields is almost eliminated. Taking the figures for the country as a whole, an adverse majority of over 220,000 would have been required to justify the Federation thinking of a strike, whereas the majority was only 16,258 against the employers' terms. In the case of South Wales the majority was relatively greater against acceptance, as 101,613 voted against and 58,490 for the offer, so that the majority against was 43,123, which, however, is less than a two-thirds majority, which is required when the question of a national strike is raised. Of course, it is appreciated that this was not a strike ballot, but at the same time it is indicative of the feeling of the rank and file, and the view is held that in the event of a strike ballot being taken it is highly questionable whether there would be a majority at all for such a drastic course. While, however, it is possible to regard the future more optimistically from the point of view of labour trouble, the situation is becoming increasingly serious from the point of view of business. It cannot be said that there is no danger of district stoppages, and foreign buyers are not operating as long as there is any uncertainty regarding supplies. The continental inquiry is at a standstill, and unfortunately it will be found before very long that collieries will be forced to suspend working owing to the scarcity of orders and tonnage. The way German coal is being shipped from Rotterdam to France, Italy, and other destinations is causing no little amount of alarm among exporters in this district, who realise that they will have increasingly difficult times during the next month or so in finding an outlet for the coals which they hold on contract and which the collieries will be pressing them to take out. The report was received here at the end of last week that there were no less than thirty-six steamers in Rotterdam loading cargoes of coal for Italy alone, which must inevitably reduce very considerably the fuel demands of that country for some weeks to come. Furthermore, the fact that steamers are getting such good despatch at Rotterdam means that shipowners are showing preference for that port instead of sending their steamers to this channel, even though outward rates of freight from South Wales rule relatively higher. The fact is that the quick way in which steamers are turned round at Rotterdam more than compensates for the lower rate of freight received. One steamer of 3700 tons is reported to have discharged her cargo of iron ore and loaded a cargo of coal from Rotterdam in two running days, whereas steamers have been waiting as long as a week or more in South Wales ports of late for a loading berth.

Miners' Notices.

There has been a good deal of uncertainty of late as to the real position with regard to miners' notices to terminate contracts, assuming that matters do not take such a satisfactory course as is desired. The present wage agreement expires on the 17th inst., and it has been stated that arrangements have been made that work shall be continued in the coalfields after that date on day-to-day contracts. Since then, however, it has been pointed out that so far as South Wales is concerned it has been agreed between the owners and workmen's representatives that the notice to end the Conciliation Board agreement does not terminate individual contracts, and that notice is required to be given by either side before contracts are ended.

Tin-platers' Demands.

The annual conference of the tin-plate section of the Transport and General Workers' Federation was held at Swansea on Saturday last, when no less than eighty-six claims were submitted for consideration with a view to their being laid before the Joint Industrial Council when it has its annual sitting in June next. Mr. E. Bevin, general secretary of the Federation, put forward a scheme for reconstructing the present methods of dealing with claims for wages advances and conditions of work, which, if accepted by the Industrial Council, will, it was considered, remove a good deal of friction, the crux of the matter from the men's point of view being that there is unnecessary delay in dealing with questions that are continually arising at the various works. Mr. Bevin pressed for the appointment of works committees throughout the trade, and that these committees should accept responsibility for settlement of purely local matters; other questions raising graver issues would still have to be settled by the machinery of the Industrial Council. As regards the demands put forward for consideration, about half of them, after being examined, were passed by the conference. Apart from the claims of the shearers, openers, smelters, tinmen and assorters, it was agreed to submit a demand for a minimum rate of £3 per week for labourers in tin works, and the general demand is once more to be put forward for payment for the annual stop-week in August.

New Bridge.

The Parliamentary and Improvement Committee of the Newport Town Council has decided to accept the tender of Sir William Arrol and Co., Limited, of Glasgow, to take down the existing Newport bridge over the river Usk and to reconstruct a five-arch bridge with steel girders, 60ft. wide, on the site of the existing bridge, in twenty-four months, for the sum of £140,275 10s. It is understood that a good deal of the steel work for the plates of the proposed new bridge will be supplied by Messrs. Arrol's new works at the King's Dock, Swansea.

New Coal Washery.

A coal washery has been erected for the Windsor Steam Coal Company (1901), Limited, at Abertridwr, and is about to be put into operation. It was designed by the Coppee Company (Great Britain), Limited, and comprises coal washing, screening, drainage, and re-loading plant, &c., housed in a building of reinforced concrete, steel, and brickwork. The whole of the plant is electrically driven. The washery has a capacity of 100 tons per hour.

Current Business.

Business is exceedingly quiet on the steam coal market, and there appears to be no disposition abroad to purchase coals from this district. The outlook for many collieries is far from satisfactory after the present week, as many of them have next to no tonnage on stem. The tone of the market has undergone a marked change and is undoubtedly easier. Tenders were recently sent in for 70,000 to 80,000 tons of Welsh coal for an electrical works in Uruguay. American firms also put in prices, but the news has now been received that the whole of the tenders for coal have been turned down and that arrangements have been made by the works in question to take oil fuel. With regard to the Roumanian State Railways' coal requirements of about 100,000 tons of steam coals for delivery from May to October, it is understood that the business is likely to come to this district provided that the financial details can be satisfactorily arranged.

Work for Swansea.

In connection with the contract for the supply of steel pipe lines for the Tata Power Company's Nila Mula or Bhira, India, hydraulic electric scheme, secured by the British Mannesmann Tube Company, Limited, Newport, it is reported that the whole of the riveted pipes, including the special junctions and expansion joints, will be manufactured at the King's Dock (Swansea) works of Sir William Arrol and Co. (Swansea), Limited.

LAUNCHES AND TRIAL TRIPS.

TAIREA, twin-screw steamer; built by Barclay, Curle and Co., Limited; to the order of the British India Steam Navigation Service, Limited; dimensions 465ft. by 60ft. by 33ft. Engines, twin-screw, triple-expansion; constructed by the builders; launch, March 6th.

CAMBERWELL, self-trimming collier; built by the Tyne Iron Shipbuilding Company, Limited; to the order of the South Metropolitan Gas Company; dimensions, 244ft. by 36ft. 6in. by 20ft. 6in.; 2450 tons deadweight. Engines, triple-expansion, 18in., 30in. and 49in. by 33in. stroke, pressure 180 lb.; launch, March 6th.

STOURGATE, steel motor tanker; built by James Pollock, Sons and Co., Limited, to the order of the Anglo-American Oil Company, Limited; dimensions, 90ft. by 19ft. by 7ft. 3in.; to carry 115 tons of petroleum spirit. Engine, 135 brake horse-power two-cylinder reversible heavy oil marine; constructed by the builders; launch, March 8th.

WELLFIELD, twin-screw motor vessel; built by the Tyne Iron Shipbuilding Company, Limited, to the order of Hunting and Son; dimensions, 385ft. by 51ft. 6in. by 30ft. 6in.; to carry 7800 tons deadweight. Engines, two sets North-Eastern-Werkspoor Diesel; constructed by the North-Eastern Marine Engineering Company; trial trip, March 10th and 11th.

ASHTREE, steel screw steamer; built by Craig, Taylor and Co., Limited; to the order of Howard-Jones, Limited, of Cardiff; dimensions, 254ft. 9in. by 36ft. 9in. by 18ft. 1in. Engines, 19in., 31in., 51in. by 36in. stroke, pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company; launch, March 20th.

LA PERLA, fruit carrier; built by Cammell Laird and Co., Limited, to the order of the United Fruit Company, of Boston, U.S.A.; dimensions, 325ft. long. Engines, four-cylinder Diesel; constructed by the builders; launch, March 22nd.

SWANLEY, single-screw motor vessel; built by Barclay, Curle and Co., Limited, to the order of Harris and Dixon, Limited; dimensions, 410ft. by 55ft. 3in. by 29ft.; 6700 gross tonnage. Engines, double-acting Diesel; three cylinders 24½in. diameter by 44in. stroke; constructed by the North British Diesel Engine Works (1922), Limited; launch, March 22nd.

INVERBANK, twin-screw vessel; built by Harland and Wolff, Limited, to the order of Andrew Weir and Co.; dimensions, 434ft. by 53ft. 9in. by 37ft.; 5200 gross tonnage. Engines, two sets of six-cylinder Diesel; constructed by the builders; launch, March 24th.

SINGLE-SCREW MOTOR TUG; built by J. Samuel White and Co., Limited, to the order of the Ports and Lighthouses Administration of Alexandria; dimensions, 70ft. by 20ft. by 10ft. Engines, Diesel direct reversible; constructed by Vickers-Petters, Limited; launch, March 24th.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—Old students are reminded that the annual smoking concert will be held at the Hotel Cecil (Princes Hall) on Friday, May 2nd, at 8 p.m., with the president, Mr. R. N. Vyvyan, M.I.E.E., in the chair. Accommodation will be available for 300.

THE RADIO SOCIETY OF GREAT BRITAIN.—We are asked to announce to members of the Radio Society of Great Britain that the ordinary general meeting of the Society, originally arranged for April 23rd, has been postponed until Wednesday, April 30th, 1924. The meeting will be held at 6 p.m. at the Institution of Electrical Engineers, Savoy-place, and will be the occasion of a lecture by Captain P. P. Eckersley on "Faithful Reproduction by Broadcast."

FARADAY HOUSE ENTRANCE SCHOLARSHIPS.—As a result of the entrance scholarship examination held at Faraday House Electrical Engineering College on April 8th, 9th, and 10th, the following awards have been made:—W. J. L. Wildbore, Strand School, Brixton-hill, the "Faraday" Scholarship of fifty guineas per annum, tenable for two years in college and one year in works; D. Parkinson, Victoria Grammar School, Ulverston, the "Maxwell" Scholarship of fifty guineas per annum, tenable for one year in college and one year in works; F. A. Peachey, Royal Grammar School, High Wycombe, an Exhibition of forty guineas per annum, tenable for one year in college and one year in works; J. G. Bentley, Merchant Taylors' School, an Exhibition of thirty guineas per annum, tenable for one year in college and one year in works; C. F. Ellis, Beckenham County School, an Exhibition of thirty guineas per annum, tenable for one year in college and one year in works; W. A. R. Smith, King Edward VI. Grammar School, Norwich, an Entrance Prize of twenty guineas.

ENGINEERING GOLFING SOCIETY.—The spring meeting of the Engineering Golfing Society will be held at Beaconsfield on Wednesday, April 30th, by the courtesy of the Golf Club. The following programme has been arranged:—In the morning there will be an eighteen-hole stroke competition for: (*a*) the "President's Challenge Cup," presented by Sir Alexander Kennedy, for members in the First Division, with handicaps of 10 and under; and (*b*) the "Wilson Challenge Cup," presented by Mr. R. P. Wilson, for members in the Second Division, with handicaps of 11 and over. A memento and a second prize will be given in each division. There will also be a prize for the best scratch score, presented by the captain, Mr. W. L. Mauscrgh. In the afternoon there will be four-ball foursomes match play against bogey, eighteen-hole round. There will be two first and two second prizes for this competition. It is hoped to start the competition not later than 10 a.m. The entries close first post on Thursday, April 24th. During the current season it is also proposed to hold a match play tournament under handicap on lines similar to those of 1923, open to all members of the Society. The entries for this tournament also close on Thursday, April 24th. Further particulars concerning the prize meeting, tournament and the Club generally may be obtained from the hon. secretary, Mr. G. M. C. Taylor, 36, Victoria-street, Westminster, S.W. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	17/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	24/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 2 6	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 19 0	4 19 0
No. 1	5 0 0	5 0 0
Cleveland—		
No. 1	4 17 6	4 17 6
Silicious Iron	4 17 6	4 17 6
No. 3 G.M.B.	4 12 6	4 12 6
No. 4 Foundry	4 1 6	4 1 6
No. 4 Forge	4 0 6	4 0 6
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 7 6 to 4 10 0	
,, ,, Foundry	4 15 0	—
(3) Northampton—		
Foundry No. 3	4 12 6	—
,, Forge	4 5 0	—
(3) Derbyshire—		
No. 3 Foundry	4 15 0 to 4 16 6	
Forge	4 7 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 14 6	—
No. 4 Forge	4 13 0	—
Basic	4 11 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 12 6 (a) / 5 17 6 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 10 0	—
Best ,,	—	—
N.E. Coast—		
Common Bars	12 10 0	—
Lancs.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	13 0 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0 to 12 0 0	
Gas Tube Strip	13 5 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 10 0	—
Ship Plates, ½in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 3/16in. to ½in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 7 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d. £ s. d.
N.E. Coast—		
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 10 0	—
Joists	10 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 5 0†	—
Light ,,	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
Manchester—		
Bars (Round)	10 0 0 to 10 5 0	
,, (others)	9 15 0 to 10 2 6	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	10 0 0 to 10 5 0	—
,, (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 15 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 0 0 to 11 10 0	
Midlands—		
Small Rolled Bars	10 0 0 to 10 10 0	
Billets and Sheet-bars	8 5 0 to 8 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 10 0	—
Angles	9 15 0 to 10 0 0	
Joists	9 15 0 to 10 0 0	
Tees	10 15 0 to 11 0 0	
Bridge and Tank Plates	10 10 0	—
Boiler Plates	14 0 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	24/3 to 24/6
Block Tin (cash)	243 10 0
,, (three months)	243 5 0
Copper (cash)	64 5 0
,, (three months)	65 2 6
Spanish Lead (cash)	31 10 0
,, (three months)	29 15 0
Spelter (cash)	32 7 6
,, (three months)	32 5 0
Manchester—	
Copper, Best Selected Ingots	69 10 0
,, Electrolytic	71 0 0
,, Strong Sheets	98 0 0
,, Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0½
,, Condenser	0 1 2½
Lead, English	35 10 0
,, Foreign	34 0 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
,, 6 p.c. to 8 p.c. ,,	£23 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£22 0 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£45 0 0	16/-
,, ,, 1 p.c. ,,	£51 0 0	17/6
,, ,, 0.75 p.c. carbon	£68 0 0	20/-
,, carbon free	1/5 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£17 for home, £17 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 5 0 scale 5/- per unit	
,, ,, 75 p.c.	£17 0 0 scale 6/- per unit	
,, Vanadium	19/6 per lb.	
,, Molybdenum	8/6 per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£130	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	26/9
,, ,, Ell	28/3
,, ,, Splint	28/- to 30/6
,, ,, Trebles	26/-
,, ,, Doubles	25/9
,, ,, Singles	22/9
Ayrshire—	
(f.o.b. Ports)—Steam	26/9
,, ,, Splint	28/-
,, ,, Trebles	26/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	22/- to 25/6
Screened Navigation	32/-
Trebles	26/6
Doubles	25/-
Singles	22/9
Lothians—	
(f.o.b. Leith)—Best Steam	24/9
Secondary Steam	23/9
Trebles	26/3
Doubles	25/6
Singles	22/9

ENGLAND.

(8) N.W. Coast—	
Steams	31/-
Household	49/- to 59/-
Coke	33/6
Northumberland—	
Best Steams	27/- to 27/6
Second Steams	26/-
Steam Smalls	16/-
Unscreened	23/6 to 24/6
Household	26/- to 28/-
Durham—	
Best Gas	25/6
Second	24/- to 24/6
Household	26/- to 28/-
Foundry Coke	30/- to 32/6
Sheffield—	Inland.
Best Hand-picked Branch	36/- to 39/- —
Barnsley Best Silkstone	34/- to 36/- —
Derbyshire Best Brights	31/- to 35/- —
,, ,, House	27/- to 29/- —
,, ,, Large Nuts	27/- to 28/- —
,, ,, Small ,,	20/6 to 23/- —
Yorkshire Hards	27/- to 30/- —
Derbyshire ,,	25/- to 28/- —
Rough Slacks	12/6 to 15/6 —
Nutty ,,	12/- to 14/- —
Smalls	8/- to 10/- —
Blast-furnace Coke (Inland)	30/-
,, ,, (Export)	f.o.b. 32/- to 33/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	29/6 to 30/6
Second ,, ,,	28/- to 29/-
Best Dry Large	28/- to 29/-
Ordinary Dry Large	26/6 to 27/6
Best Black Vein Large	29/- to 30/-
Western Valley ,,	28/- to 29/-
Best Eastern Valley Large	28/6 to 29/6
Ordinary ,, ,,	27/- to 28/-
Best Steam Smalls	20/- to 21/-
Ordinary ,,	18/- to 20/-
Washed Nuts	28/- to 30/-
No. 3 Rhondda Large	29/- to 30/-
,, ,, Smalls	23/6 to 25/6
No. 2 ,, Large	25/- to 26/-
,, ,, Through	21/- to 23/-
,, ,, Smalls	18/- to 19/-
Coke (export)	55/- to 60/-
Patent Fuel	29/- to 32/-
Pitwood (ex ship)	26/- to 27/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	42/6 to 45/-
Seconds	40/- to 42/6
Red Vein	32/6 to 35/-
Machine-made Cobbles	50/- to 52/6
Nuts	45/- to 52/6
Beans	47/6 to 50/-
Peas	29/- to 31/-
Breaker Duff	13/- to 13/3
Rubbly Culm	16/6 to 17/-
Steam Coals:	
Large	24/6 to 26/6
Seconds	22/- to 24/-
Smalls	15/- to 18/-
Cargo Through	19/- to 22/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

† Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

An Unstable Situation.

THE belief that a too sudden appreciation in money values would have the effect of checking business has been fully justified during the past week. Now that foreign buyers have no advantage in purchasing in this market, manufacturers have to look to the home demand, and in view of the uncertain situation consumers hold aloof, with the result that the volume of business being done is much smaller than usual. At the same time, foreign competition is a factor that has to be taken into account, especially for certain kinds of machines. The recent activity has developed into something like stagnation, and no fresh movement can be anticipated until the financial outlook becomes more settled. Nevertheless, there is still a fair amount of work in hand, and an almost entire absence of unemployment continues to be a gratifying feature of the French industrial situation.

Wagon Builders.

The failure of one of the biggest wagon building concerns, which was constituted during the war and became amalgamated three years ago with other important firms, has drawn attention once again to the unsatisfactory condition of the wagon building industry. At the time of the formation of the Société le Matériel Roulant it was believed that the wear and tear of rolling stock resulting from war service would have necessitated the almost complete renewal of locomotives and wagons on the French railways. The surrendering of German material, however, and the heavy expense that had to be incurred in the reconstruction of permanent works, prevented the railway companies from purchasing locomotives and wagons, and they endeavoured to tide over the difficulty by repairing the German, American, and other material which gave only partial satisfaction and did not provide enough employment to builders. At the same time the railway traffic has grown considerably during the past three or four years, and the dearth of trucks is causing serious uneasiness all over the country. Some of the companies are now giving out orders for new rolling stock; but, owing to the need for work, competition is so keen that even those firms which have secured large orders are unable to make a satisfactory profit. In view of the critical situation caused by the dearth of trucks the railway companies are being urged to purchase what they require without further delay so that the locomotive and wagon builders may escape what threatens to be a disaster for the industry. On the other hand, the companies which are electrifying their lines have ordered large numbers of electric locomotives and motor coaches.

Road Construction.

A circular has been sent to all the chief engineers of the Ponts et Chaussées containing instructions, to be observed in the building of roads, that offer a certain interest in view of the criticisms frequently made that the present system of road construction does not fulfil the requirements of modern traffic. The Minister of Public Works, however, does not recommend any special system of roadmaking, although he declares that the use of so many different materials for road surfaces must be abandoned, and he appears to prefer granite setts wherever the cost allows of their being employed. He nevertheless deprecates the practice of repairing roads by paving them with new granite setts in the middle and using the old ones at the sides. New material should be employed for paving the whole of the road. As a matter of fact, the construction of granite-paved roads is only limited by the initial expense, for the best and most durable results are obtained with small blocks closely set in a peculiar form, such as are fairly common in Belgium and in the North of France. The construction, however, is left to the initiative of the chief engineers on condition that a certain uniformity is observed, and the desire for uniformity is, indeed, the reason for the issue of the circular. Objection is taken to the variety at present existing in the construction, dimensions and the bordering of the roads, which the Minister of Public Works insists should be uniform, even to the spacing and character of the trees by the roadside. The main roads should have a width of 6 m., which may be increased to 7 m. when passing through villages or where required by local traffic, and it is only in exceptional cases that the width can be reduced to 5 m. The cambering of the road varies according to the materials employed. In the case of ordinary macadam the camber must not exceed 1/50 of the total width; tarred macadam, 1/50 to 1/60; bituminous or asphalt surfaces, 1/70 to 1/80; concrete, 1/80 to 1/100; and granite setts, 1/60 to 1/70. The border on each side must be above the level of the road, although not exceeding 4in.

Naval Construction.

The Senate having authorised the putting in hand this year of a number of vessels forming part of the second instalment of the programme of naval construction, the navy is regarded as having passed through a crisis which seemed to imperil its early future. It was feared that, in view of the financial situation, the Senate would have hesitated to confirm the vote of the Chamber, but the decision arrived at last week to permit of no interruption in the carrying out of the work has made it fairly certain that the new navy will be created within the period stipulated. This year two of the 10,000-ton cruisers will be put on the stocks. In the design nearly everything is sacrificed to a speed of 34 knots. They will have eight 203 mm. guns and sixteen anti-aircraft guns. The six destroyers, with a displacement of 1460 tons, are to be built for the same speed. A high surface speed is also a primary consideration in the design of the two 1500-ton submarines which are intended to manœuvre with the light squadrons.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

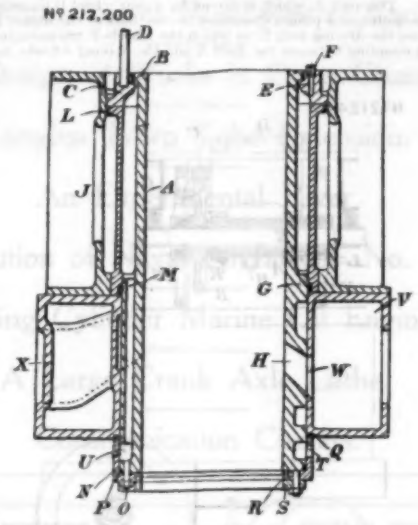
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

212,200. November 2nd, 1923.—IMPROVEMENTS IN OR RELATING TO CYLINDERS FOR INTERNAL COMBUSTION ENGINES, Swan, Hunter and Wigham Richardson, Limited, of Neptune Works, Walker, Newcastle-on-Tyne; Frank Rowntree, of 3, King's-road, Monkseaton; and Paul Belyavin, of 13, Otterburn-terrace, Jesmond, Newcastle-on-Tyne.

The chief object of this invention is to provide improved means of introducing cooling water at the lower end of the liner, and the invention is particularly applicable to the type of cylinder in which the liner is suspended at the upper end of the cylinder and is free to expand downwards. In the drawing A is the cylinder liner having a top flange B, by which it is secured to the cylinder cover through the sandwich plate or ring C, which has studs D to make the pressure joint between the liner and the cover and a water passage E with ferrule F through which cooling water is supplied to the cylinder cover. The lower flange G of

Nº 212,200

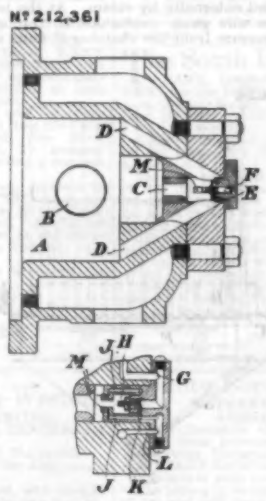


the liner has the usual ports, the scavenging port H being shown at one side. J is the entablature supporting the cylinders. The cylinder jacket is secured to the sandwich plate C by the flange L and there is a water joint M between the jacket and the liner. N is a ring fitted over the lower end of the liner and bolted to the bottom flange of the liner by studs O. The ring N is provided with water joints P and Q, packing ring R and a gland S provided with studs to keep it in position. The cooling water is introduced through the hole T in the ring N and enters the distributing channel U. The entablature J carries the box V through which the lower part of the liner passes, making a sliding joint which allows the liner to expand and contract axially, the box V being provided with the inlet port W and exhaust port X. Several modifications of the invention are described.—*March 6th*, 1924.

212,361. January 23rd, 1923.—FUEL SPRAYS, G. M. Blackstone, F. Carter, and E. Carter, Rutland Engineering Works, Stamford, Lincs.

The object of this invention is to provide a fuel spraying jet which will not carbonise up too readily when working on light loads. It comprises a cylindrical plug in which there are three ducts, a central one for the compressed air and two outer parallel ones for the liquid fuel. In the drawings A is the combustion

Nº 212,361



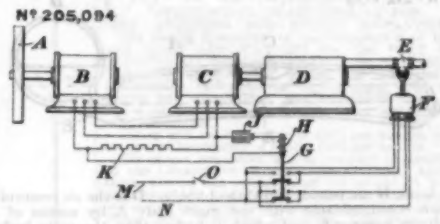
chamber and B the exhaust valve. C is the central or main air port and D D the air circulating ports. E is the cylindrical plug. F is the central or air duct supplied with compressed air through the port G. This duct in fitted with a nipple H. J J are the liquid fuel ducts connected with the annular duct K supplied with fuel through the port L. M M are the fuel delivery holes.—*March 13th*, 1924.

DYNAMOS AND MOTORS.

205,094. October 4th, 1923.—IMPROVEMENTS RELATING TO THE CONTROL OF ELECTRIC MOTORS, *Metropolitan-Vickers Electrical Company, 4, Central-buildings, Westminster.*

This invention relates to motor control systems and particularly the control of motors for driving loads having unusually heavy fly-wheel effects. In the diagram a fly-wheel A of a gyroscope is directly connected to an induction motor B which is supplied with current from a generator C coupled to a turbine D. E is a throttle valve, actuated by a motor F. A relay G with an operating coil H controls the direction of the motor F. In series with the coil H a condenser J is connected, and across this condenser a resistance K is shunted, the resistance also being in series with the motor B. The motor F is supplied with current from an auxiliary circuit comprising conductors M N and a switch O. On closing the switch the motor F receives current through the relay G. The motor gradually opens the valve E and starts the turbine, when the generator C begins to supply current to the motor B. When the current has attained

Nº 205,094



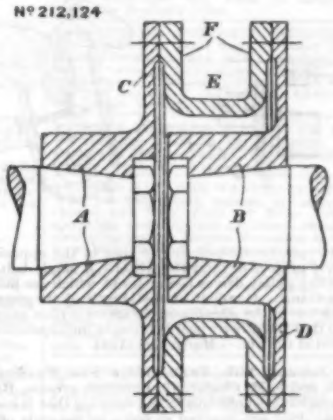
a certain value, however, the relay G switches off the motor F. If the accelerating current of the motor B continues to rise the relay G reverses the direction of rotation of the motor F, which partially closes the valve E. When the value of the accelerating current is sufficiently decreased the relay G again disconnects the motor F, and if insufficient power is then supplied to the motor B the relay re-connects the motor F so that it supplies more pressure to the turbine. At a low generating speed the condenser J offers a high impedance to the current in the relay coil H, whereas at a high speed it offers a relatively low impedance. Thus as the motor B approaches its normal speed the relay G becomes more sensitive and operates at a lower value of current. Consequently the motor F throttles the pressure to a minimum value for which the controlling apparatus has been adjusted. It is evident that the coil H may be arranged to operate at any desired current value, and that the condenser J may be given a capacity which will enable the gear to operate in the correct manner.—*March 13th*, 1924.

TRANSMISSION OF POWER.

212,124. March 16th, 1923.—IMPROVEMENTS RELATING TO FLEXIBLE COUPLINGS, Karl Baumann, of Northwood House, Barnfield, Urmston, Lancaster, and the Metropolitan-Vickers Electrical Company, Limited, of 4, Central-buildings, Westminster.

This invention relates to that type of flexible coupling comprising a pair of sleeve members adopted to be secured to the shafts to be united by a distance piece capable of transmitting the driving torque from one shaft to the other. The coupling

Nº 212,124

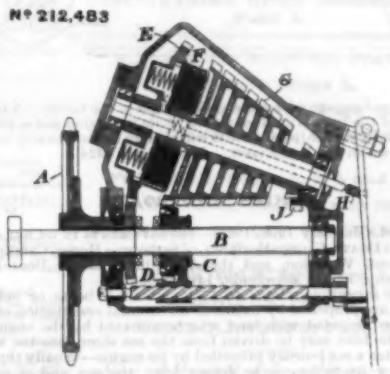


comprises sleeve members A and B with end flanges C and D, which are united by a torque transmitting distance piece E, the end flanges C and D being arranged at the ends of the sleeve members, which, when the coupling is assembled, are placed at the ends remote from and adjacent the ends of the shafts respectively. In the form illustrated the end flanges C and D are flexible and the distance piece E, which is of tubular formation with end flanges F, is relatively rigid.—*March 6th*, 1924.

212,483. July 13th, 1923.—VARIABLE-SPEED GEARING, F. J. Healey, Kingston Lodge, King's-road, Richmond.

In this gear-box A is the driver and B the driven shaft. The

Nº 212,483



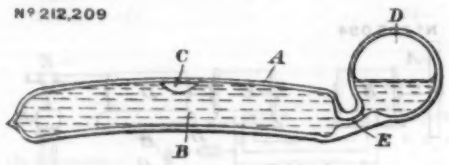
shaft B is castellated, and on it there slides a fitting C. Round C there is a toothed ring D and the two are connected together by balls in recesses which allow D a certain amount of angular free-

dom. The driver A drives an oblique wheel E and, through a friction clutch F, the nest of conical wheels G. The ring D can be moved along the shaft B by the mechanism shown to engage with any of the wheels G and at the same time the clutch F is operated by the segment H. J is a reverse gear.—*March 13th*, 1924.

MEASURING AND TESTING INSTRUMENTS.

212,209. December 6th, 1923.—Improvements in or relating to Spirit Levels, E. R. Watts and Sons, Limited, and Samuel Weston, both of 123, Camberwell-road, S.E.

This invention applies particularly to spirit levels used where extreme changes of temperature occur, as, for example, when levels are used on aeroplanes. According to the invention, the size of the bubble is automatically maintained constant or approximately constant. In the drawing A is the main body of

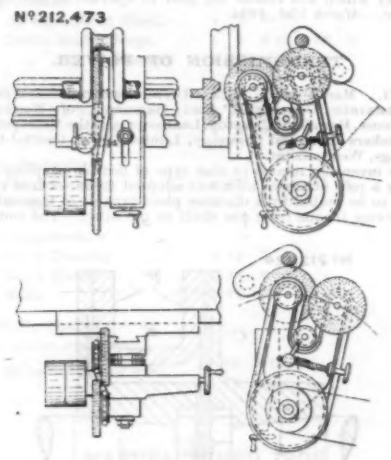


the level, B the liquid, and C the bubble. D is the air reservoir, which communicates with the main body A by means of a capillary passage E, and which is higher than the main body. In the level illustrated, which is particularly intended for use on aircraft, the main body A is slightly curved as shown and the proportion of air to liquid is approximately one to three, the liquid used being one part of distilled water and two parts of pure alcohol.—*March 6th*, 1924.

MACHINE TOOLS AND SHOP APPLIANCES.

212,473. June 23rd, 1923.—Grinding Crank Shafts, L. Kellenberger, 4, Rehetobelstrasse, St. Gall, Switzerland.

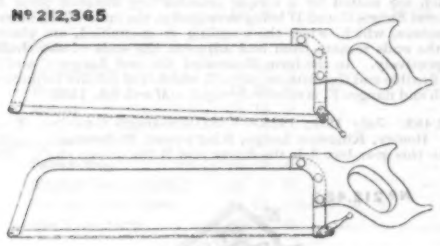
The object of the inventor is evidently to get the grinding wheel as close to the crank web as is possible for grinding the fillets. He consequently uses two wheels which overlap slightly and are driven by pulleys on opposite sides. Each pulley



occupies the space corresponding to that of the opposite wheel and does not project beyond the wheel. A single belt running round a jockey pulley drives both wheels, which are mounted in a swinging frame. One-half of the length of the crank pin is ground with one of the wheels and the frame is then swung about its pivot so that the other wheel is brought into operation for the opposite end of the pin.—*March 13th*, 1924.

212,365. January 24th, 1923.—Hack Saw Frames, T. W. Challis and S. M. Challis, 47, Faircross-avenue, Barking.

This invention is so obvious in the drawing that it needs little description. Pins are inserted in holes in the ends of the saw

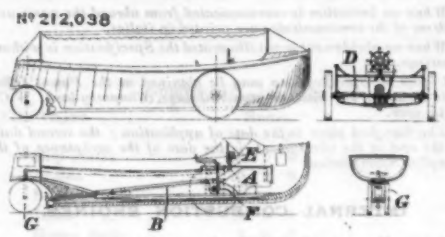


blade and engage with slots at either end of the frame. A toggle lever at the back is used to put the blade in tension and is pushed past the dead centre so that it will remain automatically locked as shown in the lower view.—*March 13th*, 1924.

SHIPS AND BOATS.

212,038. January 19th, 1923.—Improvements in or relating to Boats, George Maclaren, of Serbourne House, Cambridge-road, Waterloo, and the Amphibious Motor Boat Company, of 37, Moorfields, Liverpool.

This invention relates to "amphibious" boats or vehicles which are propelled by means of an internal combustion engine and are provided with land wheels actuated by the engine so that the boat may be driven from the sea shore into the water and after a sea journey propelled by its engine—usually through a screw propeller—it is driven from the sea and on to the shore again. The drawing shows a boat in which there is an internal combustion engine A, to the shaft B of which a screw propeller is attached. There is also an axle shaft D, which is connected to the land wheels. The engine shaft B is fitted with a worm wheel E, which is in constant mesh with a crown wheel F on the axle shaft, and when a dog clutch is brought into action the land wheels are driven at reduced speed. When, on the other hand, the dog clutch is disengaged the propeller is driven by the

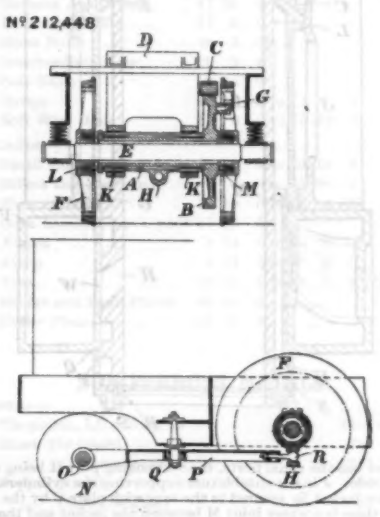


engine direct. At the stern of the boat there are a pair of end wheels G, and these wheels enable the boat to be steered on land, and they also act as a rudder when it is in the water.—*March 6th*, 1924.

TRAMWAYS AND RAILWAYS.

212,448. March 17th, 1923.—Improvements in or relating to Devices for Transmitting the Rotary Motion of a Motor to the Wheels of Vehicles, *Société Anonyme des Ateliers de Sécheron, of Avenue Blanc, Geneva, Switzerland.*

This invention relates mainly to devices for transmitting the rotary motion of an electric motor mounted rigidly on a vehicle frame to a set of wheels with side play relatively to the frame. The quill A, which is driven by a gear wheel B mounted on the quill and a pinion C secured to the shaft of the motor D, encloses the driving axle E on which the wheels F are mounted. G is a coupling between the quill A and the driving wheels, and

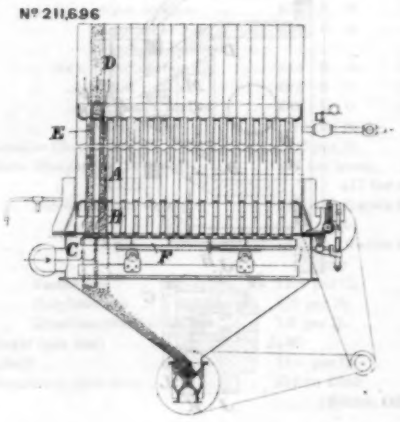


this coupling can move in a vertical direction relative to the quill. The quill is guided in a casing H which is supported at K on the motor in such a way that it can be displaced laterally. In the hubs of the wheels F springs L are inserted and are provided with steel heads M. These springs take up lateral shocks transmitted by the driving wheels to the quill and also enable the driving axle E to take up an oblique position relatively to the quill. The wheels F form, with another set of wheels, a Krauss-Helmholtz bogie. The axle O is supported by a shaft or lever P, which is mounted on a pivot pin Q and is connected to the casing H or to the quill by means of a ball joint R.—*March 13th*, 1924.

MISCELLANEOUS.

211,696. February 15th, 1923.—Grain Drying Apparatus, H. Simon, Limited, and C. Raeburn, 20, Mount-street, Manchester.

In this dryer the grain descends through long narrow tubes A, which are heated externally by steam. At the bottom of the tubes there are wire gauze extensions B, through which air under slight pressure from the chamber C finds access to the



tubes A. The air takes up moisture from the heated grain and escapes by way of the ducts D. In order to prevent the moist air coming into contact with the comparatively cool incoming grain, partitions E are arranged in the tubes and extend downward to a zone where the grain is warm. A reciprocating grid F regulates the outflow of the grain.—*February 28th*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TUESDAY to THURSDAY, APRIL 22ND to 24TH.

International Cement Congress.—At Olympia. For programme see page 368.

THURSDAY, APRIL 24TH.

Institution of Locomotive Engineers.—The Engineers' Club, Coventry-street, London, W. 1. "Terminal Station Working," by Mr. J. Pelham. 7 p.m.

FRIDAY, APRIL 25TH.

Institution of Mechanical Engineers.—Graduates' visit to Messrs. J. Lyons and Co., Cadby Hall, Kensington, London, W. 1. 5.45 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Aluminium Electrical Conductors for Overhead Power Transmission," by Mr. H. G. Williams. 7.30 p.m.

SATURDAY, APRIL 26TH.

Institution of Automobile Engineers.—London graduates' visit to the Lee Bridge pumping station of the Metropolitan Water Board. 2.30 p.m.

MONDAY, APRIL 28TH.

Faraday Society and the Institute of Metals, with the Co-operation of the British Non-ferrous Metals Research Association and the Institute of British Foundrymen.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. General discussion on "Fluxes and Slags in Metal Melting and Working." 3 p.m.

Illuminating Engineering Society.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Discussion on "Some Problems in the Lighting of Textile Mills," to be opened by Messrs. E. L. Oughton and P. J. Waldram. 8 p.m.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Paper, "Light Alloys for Pistons and Connecting-rods," by Dr. L. Aitchison. 7.30 p.m.

TUESDAY, APRIL 29TH.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Informal meeting. Discussion on "Coil *versus* Magneto Ignition." 6 p.m.

Institution of Electrical Engineers: North Midland Students' Section.—The University, Leeds. Annual general meeting. 7 p.m.

WEDNESDAY, APRIL 30TH.

Engineering Golfing Society.—On the course of the Beaconsfield Golf Club. Spring meeting. 10 a.m.

Institution of Automobile Engineers: North of England Centre.—Milton Hall, 244, Deansgate, Manchester. Paper: "Light Alloys for Pistons and Connecting-rods," by Dr. L. Aitchison. 6.30 p.m.

Liverpool Engineering Society.—9, The Temple, Dale-street, Liverpool. Annual general meeting. 8 p.m.

Radio Society of Great Britain.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London. Lecture by Captain P. P. Eckersley on "Faithful Reproduction by Broadcast." (Note.—This meeting was originally arranged to be held on April 23rd.) 6 p.m.

THURSDAY, MAY 8TH.

Iron and Steel Institute.—Hotel Cecil, Strand, London, W.C. 2. Annual dinner. 7 for 7.30 p.m.

THURSDAY and FRIDAY, MAY 8TH and 9TH.

Iron and Steel Institute.—Institution of Civil Engineers, Great George-street, London, S.W. 1. Annual meetings. For programme see page 395. 10.30 a.m. each day.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Ormerods' Tool Company, Limited, of Hebden Bridge, asks us to state that it has removed its London office from 10, Eastcheap to 302, Abbey House, Victoria-street, S.W. 1. Telephone, Victoria 1239; telegrams, "Abelard, Sowest, London."

Messrs. S. and J. Bailey ask us to state that they have removed their offices from 13, Bennetts-hill, Birmingham, to Princes Chambers, 6, Corporation-street, Birmingham. Their telegraphic address and telephone number will be unaltered, namely, "Mining, Birmingham," and Central 5340 respectively.

Vickers and International Combustion Engineering, Limited, asks us to announce that it has removed from 4, Central-buildings, Westminster, to Africa House (fifth floor), Kingsway, W.C. 2, where in future all correspondence should be addressed. The telegraphic address is "Vickomb, Westcent," and the telephone numbers Holborn 1384 and 5.

Messrs. Sir Alex. Binnie Son and Deacon, of 30, Buckingham-gate, Victoria-street, Westminster, S.W. 1, inform us that they have taken into partnership Mr. Harold J. F. Gourley, M.Eng., M. Inst. C.E., F.G.S., who has been intimately associated with the firm for many years. The firm will continue to practise under the style of Sir Alex. Binnie, Son and Deacon.

Royal Institution.—The after-Easter session at the Royal Institution will open on Tuesday, April 29th, when Professor Barcroft begins a course of four lectures on "The Effect of Altitude on Man." The Tyndall lectures will be delivered this year by Major M. S. Tucker, Director of Sound Ranging in the Army on Acoustical Problems. On Wednesday, April 30th, and Thursday, May 8th, Mr. F. Balfour Browne will give two lectures on "Social Life Among Insects;" on the succeeding Thursday afternoons Dr. E. V. Appleton will deliver two lectures on "Atmospheric Interference on Wireless Telegraphy." The Friday evening meetings will be resumed on May 2nd, when Sir Alexander Kennedy will deliver a discourse.